PUBLICATION OFFICES

168-177 POTTER BUILDING, NEW YORK.

Telephone Call: Murray 586. Cable Address: "Electrical," New York.

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New Advertisements.

In the growth of THE ELECTRICAL WORLD in circulation, size and general improvement, the value of its columns for reaching those engaged in electrical pursuits or interested in electrical matters has not failed to be appreciated by advertisers. Readers will find it to their advantage to keep their eyes on the advertising as well as the reading columns. The following are the new advertisements in this issue:

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VOL. X. NEW YORK, OCTOBER 8, 1887. No. 15.

WE illustrated last week what was claimed to be a decided improvement on the Ader type of telephone transmitter, and which has gone into extensive use in the German telephonic circuits. The inventors have, it seems, prevented the rattling of the carbon pencils by cushioning them through the medium of a spring. In so doing they have come back to the well-known type of Berliner and Blake transmitters, merely substituting carbon pencils for buttons.

AMONG the papers on electrical subjects presented before the British Association, were several by Mr. W. H. Preece. We have printed the more important, and publish another this week. The results he has obtained with copper wire, as described in one paper, are highly interesting, while the tests reported also by him as to the specific resistance of commercial iron wire, and the coefficient of self-induction in telegraph wires are of the first importance as regards several features of telegraphic construction and operation.

IN his presidential address before the British Association, an extract of which appears on another page, Sir Henry Roscoe draws attention to the intimate relation which exists between the chemical activity and electrical resistance of liquids. This branch of study, which has hardly been touched as yet, seems a most fruitful field of research, and, as Lord Rayleigh has pointed out, the study of the electrolytic actions in chemical reactions will greatly aid in the understanding of the nature of the atter.

WE give on another page a description by Mr. Geo. B. Prescott, Jr., of a new arrangement by means of which the range of work of the condenser is largely increased. Heretofore, in order to secure a large variety of graduated capacities it was necessary to combine a number of individual condensers, because the sections of condensers as usually constructed could only be connected in series. By the application of the plug switch in Mr. Marshall's new apparatus, the sections of the condenser can be coupled in any desired manner, so that a large range of capacities is obtained with convenience.

WE print this week the excellent discussion on Mr. Reckenzaun's paper, read before the American Institute of Electrical Engineers. From this discussion it appears that an exhaustive series of tests of the various gearings proposed for electric street cars would be highly desirable. The existing data and statements regarding the efficiency of different forms of gearing, while tolerably complete, are nevertheless wanting in several details relative to this particular application, and the greatly improved results claimed to have been attained with forms heretofore considered inapplicable to the purpose make such a test all the more necessary to a solution of this problem.

THE recent combination between the Westinghouse, Sawyer-Man and Thomson-Houston companies is attracting considerable public attention, to judge from the number of newspaper articles that have been devoted to the subject. This is not unnatural, for a combination so strong in every respect must necessarily have a marked influence on the future of electric lighting in this country. In our columns this week will be found quotations from the Boston and Philadelphia papers, and the New York papers have also found space to discuss the situation. All this is striking evidence of the interest felt in such matters. It will not be many years before the daily press has as much to say about the doings of electric light and power companies as it now has about telegraph and railroad companies.

WE have recently had occasion to draw attention to what appeared to be well-authenticated facts in regard to the curious effects of lightning storms upon electric light circuits. Our attention is now called to the fact that the same agent is found to be a disturbing cause in the operation of railway signals. The latter, as a rule, are operated on the closed circuit system, and any break in the line would cause the signal to be set at danger. It can be readily understood, however, that in certain situations a ground might still preserve the continuity of the circuit, and prevent the setting of the signal at danger. This is specially liable to occur where underground circuits are employed, in which lightning is liable to perforate the insulation, admitting moisture. Detection of such faults may be delayed until an accident caused thereby emphasizes their presence. In other cases lightning passing over a wire is liable to set a signal not intended, and thus cause delay and annoyance, to say the least. Hence, it is suggested that electric railway signals should be so arranged that the effects of lightning can be eliminated.

WHILE for telegraph work it has always been considered desirable to provide cables of the highest insulating quality attainable, experience in telephone work has shown that a uniform low resistance in telephone cables gives better results. The analogy for this may be looked for in the better working of overhead lines where the resistance rarely approaches that insisted upon in good cables. In the paper read by Mr. B. E. Sunny before the Telephone Exchange Association, attention is called to this fact, and, according to Mr. Sunny, instead of specifying cables to have a "fancy" insulation resistance of from 300 to 800 megohms per mile, it is better in telephone work to have an insulation resistance of not less than one and not more than five megohms; but the permanence of this latter insulation must be insisted upon. Indeed, so well recognized does this seem to be that at least one manufacterer of telephone cables has recently patented a method of intermixing a partially conducting material with the insulating medium so as to effect a continuous, uniform degree of insulation lower than that of the insulating material alone.

WHAT is to become of the Baltimore & Ohio telegraph property, has been a very interesting question during the past week or two, and its discussion has filled not a few columns of the daily papers. One well-informed gentleman remarked this week: "It is no secret that the corporation is hard pressed, and is trying to curtail expenses. There has been a prolonged movement on the part of certain interested gentlemen to form a powerful syndicate to get control of the telegraph system. A committee is at work investigating the plant, and the company is trying to make a good showing for the benefit of the committee. It is not likely that the report will be ready for a month yet, but I should not be surprised if the committee, before it is through, discovered something sensational in the books It has been intimated in my presence that there are liable to be spicy revelations when the accounts of the railroad and telegraph departments are examined." The scheme afoot contemplates, or did, an alliance between the United Lines, the Postal Company, and the Baltimore & Ohio, which was, or is, to be brought about with the aid of the Associated Press and men like D. O. Mills. This would make a powerful combination apparently, but the scheme, in my opinion, is too grand to be successful. It has also been reported that Mr. D. H. Bates has been actively trying to form a combination strong enough financially to carry on the business, and there is no good reason why in his hands the company should not prosper; but up to date, it would appear, that "deal" has not been consummated. All we can hope for is an early settlement of the matter and better times for the staff and the operators.

THE intention of an American syndicate to introduce the telephone into China under an exclusive franchise from the Celestial Government, and to enter also upon the telegraph business there, makes any news from China of great interest at the present time. As many, probably all, of our readers are aware, the field is not altogether unworked, and an item from that quarter just to hand may lead to the inference that some opposition will be met with. The latest advices from Hong Kong are to this effect: "An arrangement is reported to have been made between the Chinese Government and the Great Northern Telegraph Company, working in conjunction with the Eastern Extension Company, for an extension of the Imperial China Telegraphs to Kalgan and Kiachta, which will give a direct telegraphic route from China to the Continent of Europe and Great Britain. It is said the Great Northern Company is to pay the Chinese Government 100,000 taels, on condition that the Chinese pay the same rate per word as the two companies, namely $2. The arrangement is to continue in force 16 years. Considerable indignation has been expressed at this attempt to obtain a monopoly, and later reports from China respecting the China-American banking and telegraphic syndicate, for which Count Mitkiewicz negotiated concessions, are very conflicting. It is stated that Yen, President of the Board of Revenue, has strongly petitioned the Empress not to grant the proposed concessions, and the China Merchants' Company has repudiated all connection with the syndicate. The English interests in China have been endeavoring to prevent the final consummatiou of the grant to America." The settlement of this dispute will be awaited with interest. It begins to look a little like a struggle between England and America for control in these matters in China If so, it is doubtful if the game is worth the candle. It is still too soon to pronounce any decided opinion on the subject, and there is room for more information from China as to the exact condition of affairs there, and the attitude of the Chinese people, who are not believed to like telegraphs any better than they do railroads and other prominent features of Western civilization.

THE valuable and weighty paper on "Ten Years of Progress in Practical Telephony," read by Mr. T. D. Lockwood last week before the National Telephone Exchange Association, brings out, we think, some interesting parallels between the early history of telephony and that of telegraphy. When the telegraph became a recognized institution in this country, the rush in construction entered into by various companies without having studied the nature of the work, especially that relating to line building, resulted in a most deplorable state of affairs. And so it remained for a long time until the report of C. F. Varley, in 1868. That report was most minute and revealed the sad condition of American telegraph wires. Defective insulation, bad joints, impure wire, etc., had made the service difficult to carry on, but the measures of improvement suggested by Varley were acted upon with promptness and vigor, and the result was a marked increase in the efficiency of the telegraph system. What thus required twenty-five years to accomplish for the telegraph is now, we are glad to note, fully recognized in the tenth year of the commercial life of the telephone. The necessity of good insulation, good joints, good wire, the elimination of retarding influences in the circuit, have all been clearly pointed out, and the advice need only to be acted upon. There is nothing that so brings the telephone into bad repute as bad service, and not even the alleged high rates have conduced as much to the cry of "monopoly" as the evident neglect of improved methods. That the necessity of improvement is being recognized, is exemplified by the fact that one of the most important reforms now being inaugurated in some of our largest cities is the changing from the single to the complete metallic circuit. Attention was long ago drawn to the advisability and, in fact, necessity of preventing induction by this most simple of methods, and we have often pointed to foreign practice in this respect. Turning back to Mr. Lockwood's paper we would say it reminds us again how desirable a good work on the telephone is, covering the same ground, but in detail. One of these days, perhaps, Mr. Lockwood will write such a book. No one is better qualified for the work than he.

The American Institute Electrical Exhibition.

The electrical exhibition given at the American Institute building in this city, under the auspices of the New York Electrical Society, is now in good shape, and this week will probably see most of the exhibits in order and in operation. Several applications for space have, however, been received during the current week. The following is a list of the exhibits and exhibitors, strictly electrical, and it will be seen that a very fine showing is made. There are, however, in addition, a large number of engineering and mechanical exhibits, of which mention will be made hereafter:

C. and C. Electric Motor Company—Motors for sewing machines, fans, elevators, etc.
C. S. Bradley—Dynamo, motors.
Julien Electric Company—Electric storage batteries.
Tucker Electric Manufacturing Company—Mather system of incandescent lighting.
Chr. E. A Grönbeck & Co.—"Challenge" electric motors, electrical and surgical instruments.
Butz Thermo Electric Regulator Company—Automatic electric heat regulator.
Austin G. Day, per Clark B. Hotchkiss—"Kerite" insulated wires and cables.
Bishop Gutta Percha Works—Insulated wires.
Dynamograph Company—Electrical typewriter.
Leopold Weil—Electric water protective system.
Standard Underground Cable Company—Telegraph, telephone and electric light cables; aërial, underground and submarine.
National Electric Service Company—Regulation of temperature by electricity.
C. McIntire & Company—Electric wire connectors and electric wire.
Scovill Manufacturing Company—Silicon bronze wire, electrical conductors.
Jerome Kidder Manufacturing Company—Electro-medical apparatus.
Washburn & Moen Manufacturing Company—Electric wires.
Wilson & Hard—Electro-medical apparatus.
Clark Electric Company—Dynamos and arc lamps.
Daft Electric Light Company—Electric railway, motors, etc.
M. W. Grovesteen & Co.—Electrical specialties.
Sprague Electric Railway and Motor Company—Motors, elevators, ventilators, etc.
H. W. Johns Manufacturing Company—Asbestos and vulcabeston goods.
Holmes, Booth & Haydens—Electrical goods, wires, etc.
Commercial Cable Company—Cables, Cuttriss recorder.
Vitrite & Luminoid Company—Vitrite & Luminoid goods lamps.
Elektron Manufacturing Company—Motors, batteries, medical apparatus.
Jas. W. Queen & Co.—Electrical, measuring and scientific apparatus.
Electrical Publishing Company—*The Electrician* and *Electrical Engineer*.
S. J. Sanford—Electrical fire alarm system.
Fuller, Holtzer & Co.—Electrical apparatus.
New Haven Clock Company—Electric clocks, Manhattan non-magnetic watch.
Otto Grüninger—Oerlikon dynamo.
Standard Paint Company—Electrical insulating paints, roofing, etc.
American Manufacturing and Supply Company—Self-winding clocks.
American Ventilating Company—Individual ventilator.
Thomas A. Edison—Pyromagnetic motor.
Edgerton Electric Motor Company—Motors.
D. Rousseau—Bells, annunciators, electric locks, etc.
Bali Electric Light Company—Dynamos and arc lamps.
Callender Insulating and Waterproof Company—Insulated wires.
Wm. Marshall—Electrical condensers.
Okonite Company—Insulated wires and cables.
Stevens Institute—Webb's dynamometer; Denton's pyrometer for measuring high temperatures.
New York Electrical Society—Large historical exhibit.
Franklin Institute—Historical collection loaned to the New York Electrical Society.
Writing Telegraph Company—Writing telegraph system.
Electrical Mail Box and Indicator Company—Electrical mail box and indicator.
National Conduit Company—Underground conduit.
Tropical American Telephone Company—Telephones and switch-boards.
Ries & Henderson—Method of increasing traction of railway motors.
Robt. F. Silliman—Models of underground cables or conduits for telegraph and electric light wires.
Manhattan Watch Company—Non-magnetic watches.
Splitdorf Wire Company—Electrical wires.
A. L. Riker—Electric launch.
H. C. Williams—Automatic governor for incandescent lamps on arc circuit.
Otis Bros. & Co.—Gas engine and dynamo.
W. E. Hyer—Electric motors.
N. Y. Insulated Wire Company—Insulated wires.
C. S. Crossman—Giles' anti-magnetic watch shields and demagnetizing machine.
T. S. Mize—Stanley Faradic battery, etc.
Prof. Elihu Thomson—Electric welding.
THE ELECTRICAL WORLD—Electrical journalism and literature.

The Hydrogen-Amalgam Process for Treating Gold Ores.

The amalgam process of extracting gold from ground ore, especially the "tailings," which has been devised by Mr. Molloy and taken up the Hydrogen-Amalgam Company, is now in operation in the West. It consists in placing the mercury in a flat pan, having a flat disc floating on the mercury; this surrounds a porous pot containing a lead anode in a solution of sulphate of soda—the cathode is the mercury itself; and the current is obtained from a small dynamo. The ground ore, with water, is fed in between the porous pot and the disc, and a circular motion is given to the disc, so as to spread the ore under it through the mercury, thus bringing every particle of ore into contact with the mercury before urging it out at the rim of the disc by centrifugal force. The electric current develops hydrogen at the mercury, and thus cures its tendency to oxidize and become ineffective, or, in technical terms, to "sicken." It is claimed that 40 per cent. more gold can be extracted from the ore in this way than by the ordinary amalgam process, and that the waste of mercury by oxidation is prevented. This use of electricity has been tried by others; but Mr. Molloy's method is somewhat different from the others. We may add that electricity has also been applied by Dr. J. H. Doe to the extraction of silver ore at Douglass Mill, Dayton, Nevada.

Edison's Improved "Phonoplex."

In the Edison duplex or "phonoplex" which has come into use on a number of railroads within the last year, the difficulties of duplexing to intermediate or way stations is overcome by adding to the ordinary Morse instruments another which responds to rapid induction impulses, such as those given by a spark or induction coil. This system, which we have already described,* has been still further

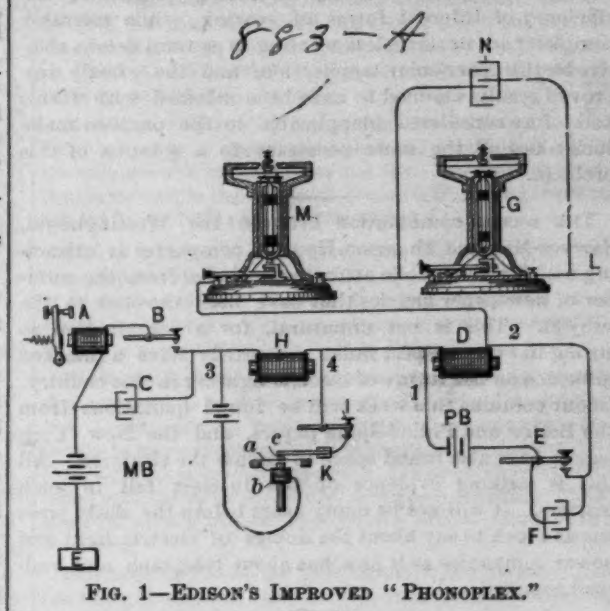
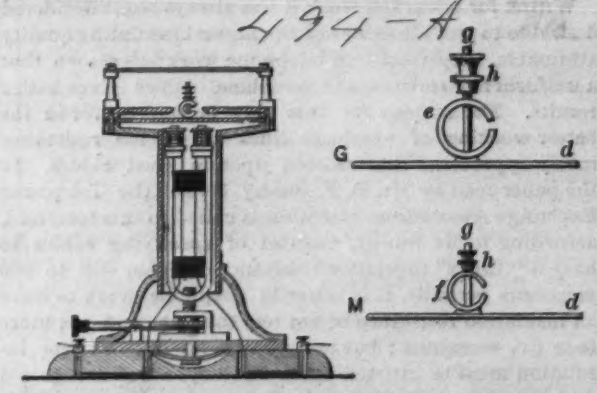


FIG. 1—EDISON'S IMPROVED "PHONOPLEX."

extended by Mr. Edison, so that it may now be used as a triplex, or equivalent to three independent circuits. This is accomplished by adding to the apparatus just described a second form of induction apparatus; but instead of transmitting and receiving Morse signals by simple induction impulses of considerable strength, as does the simple induction apparatus, this third apparatus employs rapidly occurring induction waves or vibrations which form a musical note, this note being divided at the transmitter into dots and dashes for producing Morse harmonic signals. Our illustration, Fig. 1, represents the arrangement of the apparatus at a terminal station. The arrangement is similar at intermediate stations except that at the latter there would be no line battery.

The line *L* is the usual Morse line, with main battery *M B*, Morse relays *A*, and ordinary signaling-keys *B*, the latter being shunted by condensers *C* to keep the line closed for the induction impulses. With these ordinary Morse instruments, telegraphing between all stations provided with them—both terminal and way—can be carried on in the usual manner by opening and closing the line-



FIGS. 2, 3 AND 4.—EDISON'S IMPROVED "PHONOPLEX."

circuit of the battery *M B*. At each office there is also a set of simple induction instruments, comprising an induction-transmitter and a diaphragm sounder or receiver. The simple induction-transmitter is composed of magnet-coils *D*, located directly in the line and shunted by circuit 1 2, including a battery *P B* and signaling-key *E*, the latter being shunted by a condenser *F* to sharpen the waves and absorb the spark. The simple induction-receiver is a diaphragm-sounder *G*, which is an instrument similar to an ordinary magneto-telephone receiver, but differing therefrom in respects which will be pointed out.

By opening and closing the simple induction-transmitter shunt at key *E* the magnet coils *D* will be charged and discharged, and simple induction impulses will be thrown upon the line, which will be responded to by the receiver *G*. The harmonic transmitter has magnet-coils *H* in the line, and shunt 3 4 around these coils includes a battery *H B*, a signaling key *I*, and a vibrating circuit-controller *K*. This last instrument has a diaphragm armature *a*, and a magnet *b*, similar to a magneto-electric telephone receiver. The diaphragm controls contact points *c*, at which the shunt 3 4 is opened and closed, these points and the coils of *b* being directly in circuit 3 4. This form of circuit-controlling vibrator is highly efficient for giving rapid vibrations.

The harmonic receiver is a diaphragm-sounder *M*, located directly in the line. Upon the diaphragms *d* of *G* and *M* are mounted hopping weights *e f*. These are held loosely by pins *g*, rising from the centre of the diaphragms and passing through the weights. Limiting-nuts *h* are screwed on the upper ends of the pins *g*. As will be seen by Figs. 3 and 4, the weight *f* of the harmonic sounder is much lighter than weight *e* of the simple induction-sounder, and while weight *e* is permitted a considerable movement on its pin, the limiting-nuts for weight *f* are adjusted so that this weight has an exceedingly small movement, which may not be more than one-thousandth of an inch. The diaphragm of *M*, carrying this light weight *f*, responds to the rapid or harmonic vibrations, which are not strong enough to sensibly disturb the heavier weight *e*, which, however, responds to the strong simple induction-waves, and, in addition, the sounder *G* is shunted by a small condenser *N*, which completely absorbs the rapidly-occurring but weak harmonic vibrations, so far as their effect upon this sounder is concerned. Thus the simple induction and harmonic instruments are independent in their action of each other and of the ordinary Morse instruments, which are too sluggish to respond to the induced impulses.

The harmonic and simple induction receivers are both diaphragm-sounders of similar construction, as shown in Fig. 2. These, as shown, have each an upright tubular body, resting on a hollow base. At the upper end of the tubular body is a larger circular case holding the horizontal metallic diaphragm. Through an opening in the centre of the top of the case the diaphragm weight projects as shown. Above this is a horizontal plate, supported by posts from the diaphragm case, the function of which is to protect the weight from accidental injury.

*THE ELECTRICAL WORLD, March 17, 1886.

A Threatened Strike by Operators.

It looked very like a strike in the offices of the Baltimore & Ohio Telegraph Company yesterday, says the New York *Times* of Oct. 2. This order was posted Friday night on the bulletin board in the operating room of the main office at 415 Broadway, to take effect yesterday:

All lady operators will work Sundays, as per order of the chief operator. All other operators will work as above, and also work an equal amount of extra without compensation. This order is imperative.

J. W. MCLAREN, Superintendent.

When the bulletin was put up the operators gathered around the board and excitedly and angrily denounced it. The women operators vowed they would not obey it, and the men said that unless it was rescinded they would quit work for good. They were finally induced to go back to their tables and finish up the night's business.

Heretofore the operators have been paid an extra day for each Sunday's work, the day being seven hours for Sunday, and seven hours of extra work on week days counting as an extra day. Under the rush of business which the office now has, fully half the night force, who go on at 5:30 P. M. and are supposed to be through their work at 1:30 A. M., are kept from two to four hours later in order to clear up their tables. The carrying out of the order would therefore mean a large amount of work for which no pay was received. The employés were still angry over the order yesterday and made arrangements for a meeting to day to discuss the situation and decide upon a course of action. This would, undoubtedly, have been to strike. It was learned, however, that the order emanated from the officials of the Baltimore & Ohio Railroad Company, and had been forced upon President Bates, of the telegraph company, so a committee of the employés communicated with the Baltimore office yesterday afternoon and protested against the order. After considerable correspondence by wire the welcome news came at 3:30 P. M. that the order had been recalled.

Reversibility of Motor and Dynamo.

To the Editor of The Electrical World:

SIR: Will you kindly inform me if it is possible to combine a dynamo and an electric motor in one instrument. I have planned an apparatus in which I wanted to use a small electric motor sometimes as a dynamo. I have read of a dynamo being used as an electric motor, but never of an electric motor as a dynamo.

WASHINGTON, D. C. JOHN CARSON.

ANSWER.—There is no difficulty in using a properly designed dynamo-electric apparatus either as a dynamo or motor, as you explain, and the same is frequently done.—EDS. E. W.

Marshall's Multiple-Series Condensers.

BY GEO. B. PRESCOTT, JR.

The continually increasing demand in this country for instruments of precision for electrical measurements has been, up to the present time, only partially met by American manufacturers. Even the apparatus of this class which has been made on this side of the Atlantic has been copied chiefly from European models, and, as a general thing, the quality of the workmanship has been, if anything, below the foreign standard. These facts have, doubtless, been commented upon by all who have had occasion to purchase standard laboratory instruments of foreign make, and have been compelled to pay the government 40 or 50 per cent. in addition to a good round price to the dealers.

From what American inventors have already done in almost all of the applications of electricity, it is reasonable to presume that if they would take up this particular branch we should soon have a line of standard measuring instruments which would compare more than favorably with those constructed by English, French and German makers. In fact we would be justified in expecting original designs and improvements which would increase the

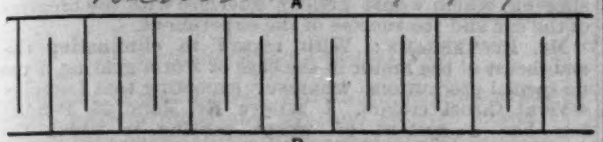


FIG. 1.

accuracy and efficacy, and at the same time reduce the cost of this class of apparatus. A condenser is probably the last instrument which one would think of selecting as a subject for improvement, and yet as an example of the transformation which electrical measuring instruments may be expected to undergo in the hands of Yankee inventors, a new standard condenser, which has been devised by William Marshall, the well-known condenser manufacturer of New York, will serve excellently well.

Before proceeding to describe Mr. Marshall's novel condenser, it may be well to say a few words about condensers in general for the benefit of those who are not especially conversant with the subject. As ordinarily constructed, the capacity of standard condensers is either fixed or variable, and they are commonly referred to, accordingly, as non-adjustable and adjustable condensers.

The leaves of a non-adjustable condenser are arranged as shown diagrammatically in Fig. 1, in which the leaves are represented by vertical lines and the connecting strips by horizontal ones. Every alternate leaf is connected permanently to the metallic terminal strip *A*, while every other alternate leaf is similarly connected to the terminal strip *B*.

The leaves of adjustable condensers are connected in the manner shown in Fig. 2. Every alternate leaf, as in the non-adjustable condenser, is permaniently in connection with the terminal strip *A*, while the corresponding alternate leaves are connected in groups to give any desired capacity, to the terminal blocks 1, 2, 3 and 4, which are placed opposite and parallel to the terminal strip *B*. These groups may be connected with the terminal strip *B* by the insertion of a metallic plug between the terminal blocks and the strip *B*, at 1, 2, 3, etc. Thus, if the figures are assumed to represent the capacity in microfarads of the corresponding sections, when the plug is inserted at 1, the capacity of the condenser would be 1 microfarad, with plugs 1 and 2 inserted the capacity would be 3 microfarads, and with all the plugs in position the capacity would be 10 microfarads. Such an adjustable condenser is simply a number of smaller condensers grouped together, but it must be remembered that in this, the common construction, the terminals of one side of each of the condensers is *permanently connected to the same metallic strip*, so that the different sections can only be connected in parallel.

Now, the law governing the joint capacity of condensers when they are connected in parallel, as in Fig. 2, is very simple, viz.: *The joint capacity of condensers in parallel is equal to the sum of their respective capacities.* But when connected in series, or multiple series, the law becomes a little more complicated. For example, the joint capacity of two condensers of respective capacities F_1, F_2 microfarads, in series is

$$\frac{F_1 F_2}{F_1 + F_2} \text{ microfarads;}$$

or equal to the product divided by the sum of their capacities. With three condensers in series the joint capacity is

$$\frac{\frac{F_1 F_2}{F_1 + F_2} \times F_3}{\frac{F_1 F_2}{F_1 + F_2} + F_3} = \frac{F_1 F_2 F_3}{F_1 F_2 + F_1 F_3 + F_2 F_3} \text{ microfarads;}$$

and so on for any number of condensers.

In short, when condensers are joined in series the joint

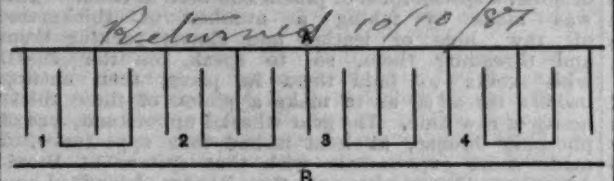


FIG. 2.

capacity of the series follows the law of the joint resistance of parallel circuits, thus:

$$\text{Joint capacity} = \frac{1}{\frac{1}{F_1} + \frac{1}{F_2} + \frac{1}{F_3} \cdots} \text{ microfarads.}$$

This expression is the exact equivalent of the preceding formula, but is preferable on account of its simplicity. In words then, *the joint capacity of condensers in series is equal to the reciprocal of the sum of the reciprocals of their respective capacities.*

When combined in multiple series the same law holds good, the total capacity of each group of condensers in parallel being taken as the capacity of a single condenser. Thus with two condensers there may be obtained four different capacities, viz.:

$$F_1;\ F_2;\ F_1 + F_2;\ \frac{F_1 F_2}{F_1 + F_2};$$

while four condensers may be grouped to give fourteen different capacities, thus:

$$F_1;\ F_2;\ F_3;\ F_1 + F_2;\ F_1 + F_3;\ F_2 + F_3;\ F_1 + F_2 + F_3$$
$$\frac{F_1 F_2}{F_1 + F_2};\ \frac{F_1 F_3}{F_1 + F_3};\ \frac{F_2 F_3}{F_2 + F_3};\ F_1 + \frac{F_2 F_3}{F_2 + F_3};$$
$$F_2 + \frac{F_1 F_3}{F_1 + F_3};\ F_3 + \frac{F_1 F_2}{F_1 + F_2};\ \text{and } \frac{1}{\frac{1}{F_1} + \frac{1}{F_2} + \frac{1}{F_3}}$$

For a larger number of condensers, the possible combinations go on increasing in a geometrical ratio.

It is obvious that advantage may be taken of this power of combination to obtain a large number of capacities from a small number of condensers, and this is just what Mr. Marshall has done in the construction of his new standard adjustable condenser, two sizes of which are illutrated in Figs. 4 and 5. The leaves in these condensers are grouped as shown in Fig. 3.

This arrangement is practically a duplication of that employed in the ordinary adjustable condenser as shown in Fig. 2. Both ends of each group of leaves are attached to terminal blocks which are free to be connected with the terminal strips or with each other in any desired combination. This modification is of the greatest importance, as it makes it possible to connect together the different groups of leaves in every conceivable way, and to obtain the widest range of capacity by almost infinitesimal variations; while for a given capacity the cost of construction is not much increased.

These condensers are constructed with the greatest care, and are not only accurately standardized, but they have besides an unusually high insulation resistance. For throwing the sections in series combinations, the connecting plugs have been provided with set nuts or thumb screws, to which conducting wires may be easily attached as required. The connecting blocks are so arranged that each section may be independently short circuited or discharged. Both the strips and blocks are so accurately set that the plugs bind perfectly, and the whole instrument is handsomely finished.

Of course, these condensers may be made of any desired sectional and total capacity. Fig. 4, for example, shows a ten-section condenser in which each section has a capacity of 0.1 microfarad, and the whole capacity is 1 microfarad. The range of the instrument is, therefore, from 0.01 microfarad to 1 microfarad by exceedingly minute gradations. Fig. 5 shows a fourteen-section condenser in which the sectional capacity ranges from 0.001 microfarad to 2 microfarads, with a total capacity of 4 microfarads and a minimum capacity of about 0.0002 microfarads. In Fig. 4 the sections of the condenser are all connected in series. In Fig. 5 the sections are joined in parallel, and a discharge plug is shown in position.

Mr. Marshall expects to exhibit a number of these condensers of various capacities in the forthcoming American Institute Electrical Exhibition, where, no doubt, they will attract deserved attention.

FIGS. 4 AND 5.—MARSHALL'S ADJUSTABLE CONDENSER.

Magnetism and Morphology.

Some experiments have been placed on record, says the London *Electrician*, in which a number of eggs were hatched out in a magnetic field, with the result that the chickens were all more or less deformed; blind, deaf, or lame. A biologist at Manchester, in course of conversation, told us that he had several times tried to repeat the experiment, but with the result that the eggs were always addled. Without professing to expound the physiological or morphological reasons for these singular results, it is at least permissible to suppose that the movements of the

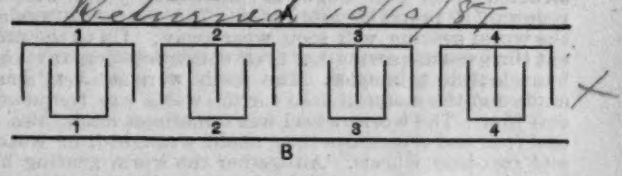


FIG. 3.

protoplasmic substance in the magnetic field set up currents of electricity, which tend to decompose the delicate organic structures of the egg so as to destroy or vitiate its vitality.

Nobili's Rings and Allied Electro-Chemical Phenomena.

Herr Elsass (in the *Am. Phys. et Chem.*) expresses the opinion in opposition to Voigt, that Nobili's rings are mainly due to currents which traverse the electrolyzed liquid nearly parallel to the metal plate. The colors obtained are not in all cases colors of thin plates; but the rings are sometimes deposits of different chemical and physical constitution. In fact, electro-chemical decomposition takes place not only at the surfaces of the electrodes, but at every point throughout the liquid traversed by the current. This is proved as follows: Plaster of Paris moistened with copper sulphate solution is poured on a metal plate, and a copper wire plunged into the still soft mass with its end very close to the plate. The plaster is allowed to set firmly, and a current is passed from wire to plate. On removing the cake, four or five colored rings are seen on its surface, corresponding rings being found on the plate. The plaster also adheres to the metal more or less firmly in different zones, and is also distorted. The central area opposite the wire is green (CuH_2O_2?) and is surrounded by rings successively white, blue, white, red (Cu) and again blue. When the current is long continued, colored deposits are also found throughout the mass of the gypsum. The colors of the rings are independent of the nature of the metal plate, when the latter does not directly act on the electrolyte. When the anode wire is of platinum, the electrolyte becomes acid and pure copper is nowhere deposited. When it is of iron, rust-colored rings are found in the gypsum plate, showing that transference of the ions takes place even in the solid. If the metal plate is made the anode, a blue circle appears round the cathode, surrounded by an intensely blue ring. When a current is passed between two wires immersed in a plate of gypsum, prepared as above on a plate of glass, circular colored rings are formed round each wire. The isochromatic lines do not correspond either with the equipotential lines or the lines of equal current intensity. If in this experiment a metal plate is substituted for the glass, rings also appear on its surface. These appear to coincide with the equipotential lines only at some distance from the wires. Theoretical views follow as to the distribution of potential in the last case. But the appearances cannot be explained by reference to this alone, as Guébhard imagines,

On Electric Street Cars with Special Reference to Methods of Gearing.

Subjoined is the discussion of Mr. A. Reckenzaun's paper on the above subject, read before the American Institute of Electrical Engineers, and published in our columns last week:

DISCUSSION.

Mr. R. W. Pope dwelt on the method employed for lubricating the worm, and in reply

Mr. Reckenzaun said: The whole gearing is inclosed almost air tight by a tank. Two or three inches of oil are then placed at the bottom of the tank, which gives a perfect continuous automatic lubrication. The teeth of the worm wheel will lift up just sufficient oil to lubricate the worm, and there will be sufficient oil always flying about to keep the whole well lubricated.

With regard to the friction surface of the worm wheel I have mentioned, that is made of phosphor-bronze, and the worm is made of steel. These two metals have a very low coefficient of friction between them. The worm is, moreover, turned out of a solid piece of steel and perfectly solid. The phosphor-bronze wheel is a toothed chair thoroughly trimmed and also polished inside. Therefore they have a perfect wearing surface to start with. The worm gearing works for a considerable length of time without any appreciable wear at all on the teeth. I think a perfectly constructed worm gear ought to run twenty years without renewal, if properly lubricated. The prejudice against the worm gearing will soon wear away. Up to the present time worm gearing has been constructed on anything but scientific principles. The teeth were at a very small angle and the material used for the worm was frequently cast iron. The worm wheel was sometimes made also of cast iron and sometimes they made wrought-iron worms and cast-iron wheels. Altogether the worm gearing has been constructed on anything but scientific principles.

Mr. Wetzler: I would like to ask Mr. Reckenzaun if he ever has tried to use a worm which instead of being cut cylindrically has been cut radially so as to conform to the radius of the wheel into which it geared; that is, the Hindley worm, of the hour glass form. This form is said to be more efficient than the straight worm.

Mr. Reckenzaun: All the worm gearing I have constructed has been made on the plan of cutting it out cylindrically.

Mr. Mailloux: I would like to add by way of information that this form of worm (the Hindley) was the very first that was used. The shape of the teeth is varied as they go toward the end near which they, so to speak, point inwardly in a radial form, as Mr. Wetzler has said.

With regard to the worm, I have watched with interest the evolution, so to speak, of means of transmission from the motor axle to the car axle, and I am very well prepared to agree with our friend Mr. Reckenzaun that it is undoubtedly one of the most important problems that we have to deal with to-day. In fact, I may say that it is the only remaining unknown quantity in the problem of electrical traction. The problem of designing and constructing electric motors has advanced by the assistance of workers, mathematicians and others until it is to day a question of engineering, you might almost say purely; but the manner in which we should dispose of the energy in order to render it available for moving the car is not unfortunately so well taken care of; and the very fact that we see so many diversified attempts to meet the severe requirements which Mr. Reckenzaun so well placed before us shows that a satisfactory solution, at least one that is satisfactory to everybody, has not yet been reached. Some are very much predisposed in favor of belting, others in favor of gearing, friction appliances, etc., etc. Now there is, I feel, going to be a certain amount of competition between different forms of rigid gearing, leaving aside for the present other forms, namely, belting, etc. Experiments have been made by very able persons on the subject, and so far nearly all of them concur in ascribing to the worm a much lower efficiency than to the form of spur gearing. I have in mind some experiments which were made under the auspices of Messrs. Sellers, of Philadelphia in which they sought to go to the bottom of the problem thoroughly and to arrive at some conclusion as to the relative efficiencies of the various forms of gearing. The results attained showed, first, that the efficiency did increase with the speed, as Mr. Reckenzaun has stated, but that this efficiency did not increase always with the speed; that it reached a certain maximum just as you would expect, and a very curious circumstance was that the forms giving the highest efficiencies were those two direct ordinary spur gearings in which the shafts are parallel with each other. Starting from that they made experiments in which the angle of the two shafts was gradually increased so that there was, so to speak, a gradual transition from the form in which the two shafts were parallel to that in which the two shafts were at right angles to each other as in the worm gear. We may say in fact that worm gearing and spur gearing will be the two extremes of a certain scale of transition, intermediate between the two extremes being placed the so-called spiral gearing, in which the teeth are placed at an angle in spirals. The results obtained by the Messrs. Sellers showed that the nearer they approached the form of the worm the lower was the efficiency. I have not in mind the figures of the efficiencies, but the experimenters themselves rather left us in doubt as to the value of their results by referring to very many circumstances which, in their opinion, would vitiate some of the results obtained, and there were certain conditions of the operation of their apparatus, etc., which they were not exactly satisfied with. I must say that I myself have always looked upon the worm with more or less suspicion. While I was not disposed against it, particularly after seeing the beautiful results obtained with it by Mr. Reckenzaun in England, yet at the same time I felt that it was to be taken under probation, so to speak. There are some disadvantages, I think, which are connected with the use of the worm, and one of them which occurs to my mind just now is the difficulty when the worm is fastened to the motor shaft in running down hill. When an electrically propelled car runs down a grade usually it is found possible to shut off the current in a great many instances, and this, of course, results in a certain saving of energy. Now, unless the pitch of the thread was properly adjusted or calculated, and the design of the thread good, it seems to me that it would be somewhat difficult for a car to move down hill with a certain ease, because of the well known difficulty of moving such an arrangement backward. It is very well known that a worm can be used to turn a toothed wheel, but it is very hard to turn the worm by means of the toothed wheel. I understand that Mr. Reckenzaun has met this difficulty, though I do not know whether he still considers it one of the things to be remedied or whether he deems the remedy that he has proposed sufficient. Now, turning back to the other form of transmission, namely, the pinion, which I have said is likely to be one of the opponents or rivals of the worm system, I have in mind some form of that kind which I saw in use a year or so ago which it seemed to me was very well adapted for the purpose that it had to serve. Recognizing the fact, of course, of a great tendency to wear in the pinion or in the gear wheel, and also the great tendency to the production of noise, a special form of pinion had been devised. This was made by taking a number of thicknesses of raw hide or leather and closely packing them and threading them, so to speak, on the shaft, with knots to hold them in place, then cutting inside a thread so as to make a pinion of these thicknesses of raw hide. The gear wheel, I understand, was of phosphor bronze, at least it had that appearance. I made some experiments with that system at Providence at the works of the Rhode Island Locomotive Works. I think the name of the system was the Bentley-Knight. I found the working of it to be satisfactory. It was entirely noiseless, and the only doubt that there was in my mind as to its success was the question of durability of the pinion. I have no doubt that if there is any wear it must necessarily come on the pinion, that being the softer substance of the two; but I have no data by which I could arrive at the comparative durability of the raw hide pinion. With regard to the chain, I may add a word which might be interesting by way of information. My experience with it goes to show that the loss from its use is not nearly as great as might at first be supposed. In that respect the pinion is placed in very nearly the same position that the worm gearing is. In other words, it depends largely on who is using it and how it is used. Mr. Reckenzaun has obtained excellent results—nobody will deny that—on that worm gearing, which has always been looked upon as the bane of the mechanic. Now the same may be stated with regard to the chain belt. It is capable of giving excellent results, but in order to obtain them a special form of chain must be used, and the secret of the success which Mr. Van Depoele has achieved in this country is due largely to the special form of chain which he has used. The connecting piece between the links has a thimble around it which acts as a roller, so that instead of having a frictional action on a toothed wheel it has more of a rolling action, and by taking care to keep the chain properly lubricated, not only is the noise greatly reduced, but the loss from friction is also very largely diminished.

Mr. Reckenzaun: I think there is only one point which requires observation on my part, and that is in regard to running down hill with worm gearing. I make the angle of the thread so that the car runs down hill very easily if we once start the worm. You can with your hands turn around the worm wheel almost at any speed you like, and I know from experience that a car which is provided with worm gearing will run down an incline of one in seventy to one in a hundred, depending on the roughness of the track, very easily. If it were not for that, and if the pitch or the angle of the worm thread were not sufficiently great, there would be no danger even in the case of running on the level road than running down hill, because as soon as you cut off the current from the motor the momentum of the car would strip off all the teeth of the wheel. If you make that angle sufficiently large you will find there is no trouble at all with reference to the point which Mr. Mailloux has pointed out. If you take the formula which I have given in the paper, and which I suppose will be published some day, and if you take the dimensions I have put down, you will find the exact angle of the worm thread, and it will be found that its angle of repose is so low that the worm wheel is bound to revolve with the greatest of ease. As regards spur gearing I have pointed out in the course of my observation in the paper, that I have been very well satisfied with, in fact astonished at, the case with which that spur gear which we use in Philadelphia is working. As regards chain gearing, I have been rather unfortunate with chains, but if I had employed such appliances as Mr. Mailloux or Mr. Van Depoele, no doubt I might have been more successful. Of course Mr. Van Depoele uses rollers, and we know that rolling friction is much easier than what I call grinding friction, where the links of the chain have to grind over the teeth. I agree with Mr. Mailloux that there will be a great competition between the different forms of gearing, and it is only that form of gearing which lasts longest and gives the least trouble which will be eventually adopted generally. But at the present time we are still in the dark as to the best form. Every one believes his own the best, because he has had the greatest experience with his own form.

Mr. Wheeler: I want to ask Mr. Reckenzaun how the gear is connected to the motor. If the motor is mounted directly on that shaft, does not the jarring of the car shake the motor up a good deal and prevent the brushes resting on the commutator? I do not think he has explained that.

Mr. Reckenzaun: The worm and its coupling are generally forged in one piece. I employ a slightly flexible coupling between this and the motor shaft. Between the bearings are springs which take off the jarring from the bed of the motor. There is very little jarring going on and we have never had any trouble with the jumping off of the brushes from the commutator. If the springs on the commutator brushes are sufficiently strong there will be no trouble. In some cases I have tried to balance the brushes by a weight at their free ends, so that the jarring, instead of jarring them off, jars them on and puts pressure upon them. I found, at last, that there was no necessity for that. There is very little trouble in that respect if it is properly adjusted in the first place. With the motor shaft flexible in the first place, and the wheel flexible to the bearings that support the frame of the motor you will find very little trouble on the points Mr. Wheeler has mentioned.

Mr. Mailloux: I would like to call attention to a point which I put down as the first on my list, but which in my anxiety to get through I omitted. I do not wish to see it passed by, because I think it is of some importance and perhaps throws light on these discrepancies relative to the efficiency of the worm which have been observed in the results of the best experimenters. I have reference to end-thrust in the motor. My own study of the theory and practice of the worm wheel has convinced me that at least a large proportion of the waste of energy due to friction in worm gearing must have been due to end-thrust. Now, the question arises why did not Mr. Reckenzaun, perhaps, employ means by which this end-thrust could be reduced, if not eliminated, and in that way obtain a much better efficiency than the others who had preceded him? I wanted to mention particularly that in analyzing the experiments made by Messrs. Sellers I was not satisfied with the precautions that they seemed to have taken to eliminate that end-thrust, and perhaps that may have been the cause of a considerable loss of energy by friction. There is another point which occurs to me. The problem of electrical traction involves a very important requirement in the matter of securing adhesion between the rails and the wheels in climbing up grades, going around curves, etc. The electric motor has not been found successful in enabling us to climb grades higher than 6 per cent., or, at the outside, 7 per cent. I have succeeded in going up a grade of 6 per cent. with a car having another car attached to it. But these are *tours de force*, so to speak, which perhaps we would not care to repeat every day. Then if we admit the necessity for a certain amount of traction — adhesion between the motor and the car — we arrive at the consideration of the importance of having the power transmitted to both axles. In a great many cases I have found by experience that the transmission of the motion to one axle was insufficient in certain kinds of weather when the tracks were not in the right condition. There would be a very severe and annoying amount of slipping, which would greatly interfere with the progress of the car and the success of the experiment.

Mr. Reckenzaun: With regard to eliminating the end thrust of the motor in the case of worm gearing, I use no special precautions whatever excepting that I employ several thrust collars. I believe Mr. John M. Pendleton has a system of worm gearing in which the thrust is eliminated by having two worms, one right-handed worm and the other a left-handed worm, so that the thrust of the one counteracts the thrust of the other.* But it has this little disadvantage, that the gearing comes very near to the ground. By this means the two driving wheels have to revolve in the same direction. The two worms revolve in the same direction, and being right and left-handed the trust is entirely eliminated. I have made one kind of worm gearing for a special purpose where two worms were attached to a motor which drove two worm wheels, and on the same shaft with the worm wheels were two large spur wheels which were used for climbing up a rack. In this case also the thrust was eliminated, so that there was only the friction of the thread of the worm and the worm wheel teeth. With regard to the problem of adhesion, it is perfectly natural that the more driving wheels you have the better will be the adhesion, because each wheel will have the same effect in assisting to start the car. I never use less than four driving wheels on my cars, and would use six if it was convenient. It is nonsense to attempt to run cars on a grade of more than 6 per cent. in wet weather. It is impossible. No electric car, or steam car, or any self-propelled vehicle with absolute certainty will climb grades of more than 6 per cent. in slippery weather. If we go beyond 6 per cent. we must have some artificial adhesion; we must introduce some rack on the road, or cables which have a positive motion. Any one who attempts to guarantee a self-propelled vehicle, whether propelled by steam or any other means on grades of more than 7 per cent., will most certainly lose his reputation.

Mr. Pendleton: In regard to the electrical propulsion of cars, while the first efforts were being made in Paris by Mr. Philippart, and the celebrated omnibus feat with which he paralyzed the residents of Paris by the exhibitions made on the Boulevard and also the run from Paris to Versailles and return, my attention was drawn to the question of power contained in the accumulator for the purpose of car propulsion, and while an examination of that apparatus failed to satisfy me as to its being a mechanical arrangement affording the best efficiency, yet the results attained in that demonstration convinced me that the value of the accumulator and motor will find a better application in the replacing of horses than of anything else, and as I was devoting my attention to experiments with the accumulator during those years I gave a good deal of study to improving the mechanical devices there adopted, which were simply to put a D 2 Siemens dynamo connected to the counter-shaft and from the counter-shaft to the wheels of the omnibus. My recollection is that the apparatus weighed about nine tons. We are all familiar with the demonstration made, and a good many are familiar with the devices used, but when I made the attempt to find something better it appeared that according to the experience of car men, and in the opinion of those who had employed various devices with compressed air or steam, it was a very difficult subject. Our oldest car-builders in conversation told me that the experiments had so far demonstrated that horses were the best things to put on cars and nothing else would do; that engines would not stand the pounding of the rail, and were very rapidly destroyed. Occasionally some invention would run smoothly for a while, but that inevitably it came to grief in a very short period. Notwithstanding this discouragement, various devices such as have been spoken of to-night were reviewed one after the other, and the device which Mr. Reckenzaun has alluded to was the final result after discarding some dozen or more. But the necessity of using the worm and worm wheel running in oil was very evident to my mind. It may be remembered by a good many here that in May, 1886, I exhibited at the New York Electrical Society a design for this system of car traction, having eliminated from it all the objectionable features that could well be done on paper. I exhibited it for the purpose of showing it and getting the opinion of those who were engaged with me in investigating mechanical and electrical questions. I was discouraged afterwards by the opinion of many—some of whom are here present—as to the efficiency of the worm and the worm wheel, and it is with the greatest pleasure that I hear so well defined and so thoroughly proved by practical experiments what I may say was a chance choice more than a scientific result on my part. It came to me intuitively as it were; it seemed to satisfy me better than any other. I have had the apparatus in model for a good many months past, but other engagements have prevented

*See The Electrical World, Aug. 7, 1886.

my doing as much work in that line as I wished I could have done. The interest in it has increased from week to week. It is only a fortnight ago that I visited Philadelphia and had the opportunity of riding upon a car which Mr. Reckenzaun had in charge. I saw there a car under thorough control, mounting grades of 5 feet in 100 feet easily, stopping in the centre of the grade and starting without any difficulty. The starting from a dead stop was with ease—much more than we would experience in a horse car, and although I had been so many years a believer and exponent of electric traction, and particularly of accumulator traction for street cars, I will state to you that I was surprised and gratified at the practical demonstration of its value that I saw. The car was run by a motor attached only to one pair of wheels. It had always been a great doubt with me whether, on grades of five to the hundred or four to the hundred, a car would have sufficient hold upon the rail to enable it to

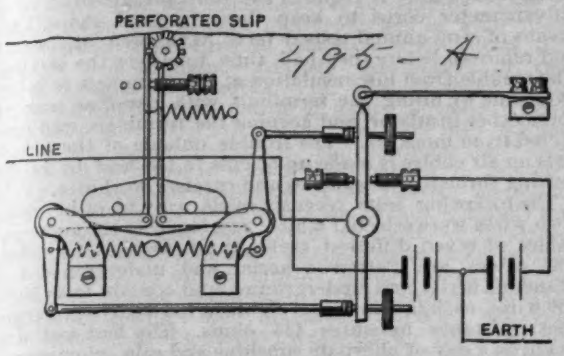


FIG. 1.—FAST-SPEED TELEGRAPHY.

mount grades of that degree. I saw a car stop on a grade, start on a grade without any slip, and go over it, and I felt that a very important question was solved by the manner in which it performed its work.

Mr. W. M. SCHLESINGER: In the Lykens Valley coal mines we enter into competition with one or two lines of horses and also with the steam engine. The mules were taken off entirely the second day, and I think that the steam engine has seen its last days also in the coal mines. It is proposed wherever steam locomotives are being used to change them for electric motors within a very short period. The trains we have to handle are sometimes as large as 100 tons. We have to take them over grades of about one per cent. to two per cent. and around 90 degree curves, one of them being 25 feet radius. We have got to start trains on these curves. The mode of transmitting the power from the motor to the wheel is chain gearing. I found that wherever the train stands the starting is very easy, or would be very easy, if it were not for the fact that the cars generally are bumped together and the load is put not all at once on the motor, but gradually. One car starts after the other, and this is an objectionable feature so far as the easy starting is concerned. If the whole train would start as one then it would move off very nicely and easily without any jar at all, and that is another reason why I think it is always preferable to have the motor geared in such a manner to the car that both start together, not the motor first and then the car. There will always be a jar if this is not the case. It is the same thing as if the chain gearing should have stretched. It will always be noticeable that the car starts far more heavily and with a greater jerk than if the chains are perfectly tight. Outside of that the weight and power required to stop the motor are so small as compared with the power required to start the whole thing that there is very little gained in starting one, especially the motor, before the other. The chains we are using in the Lykens Valley coal mines are the chains Mr. Van Depoele is using, and side by side with that a chain that I have specially constructed for the purpose. The links are made of phosphor-bronze and the pins are of steel, having a wearing surface of two square inches. The chain with a thimble is not giving much satisfaction up

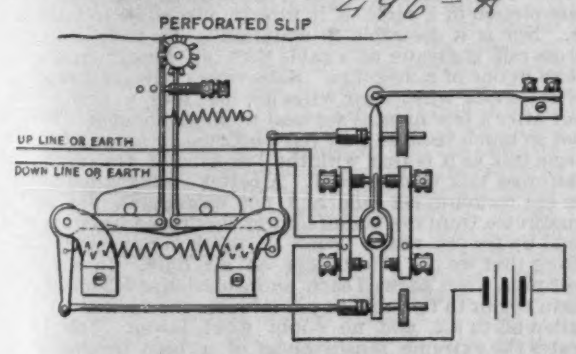


FIG. 2.—FAST-SPEED TELEGRAPHY.

there. I suppose it is because of the very heavy strain on it.

Captain MICHAELIS: A remark that Mr. Schlesinger has just made in regard to the increased shock due to the successive movement of the cars constituting the train brings to my mind a remark that the reader of the evening also made in his paper which I saw was clearly founded on experiments and not simply the result of theory. That remark was that the duty upon the motor was greater in starting the train than afterwards, and Mr. Mailloux continued somewhat in the same manner. Now, during the present year there was a series of remarkable experiments made at Burlington under the auspices of the Master Car-Builders' Association which will bring about, I think, an entire revolution in the method of connecting trains, and I am fain to confess that these experiments appear to upset all our preconceived theories as to the duty of the motor in starting trains. I speak on the subject because I am at present engaged on this coupler question and therefore take some interest in it. These experiments showed that the greatest duty upon the locomotive in this case was actually after the whole train had been started, and it is very curious. The result of that has been that the Coupler Committee of the Master Car-Builders' Association—all prominent railroad men in active practice—unanimously agreed at the convention in Minneapolis that the future coupling of cars shall be tight and not loose and have recommended the abolition of the pin and link coupler and the substitution of a close vertical hook, which I think coincides with what Mr. Schlesinger has said.

Mr. MAILLOUX: With regard to the starting of the motor shaft first, I have seen the virtue and the value of that point demonstrated quite recently by means of a system in which the motor is started, first giving free scope to the full electromotive force of the battery and allowing it to run at a very high speed and accumulate energy in the form of momentum, so that not only that part of the work has been done, but we have even stored a certain amount of energy there, which, when a device is applied, shall enable us to make use of that stored energy to start the car itself. I have seen the results demonstrated by a gentleman who has a system of traction, and I must say that it struck me very favorably indeed. He used a frictional device in the connection between the motor and the other, also combined with spur gearing, but when I saw the ease with which he started and stopped and overcame grades, etc., I was convinced there must be something in it. I still believe it.

Mr. PENDLETON: I call Mr. Mailloux's attention to the value of the electric motor, particularly for the purposes for which we are applying it, and, that is, that the electric engine has its greatest traction at the time of starting and, therefore, more particularly valuable for the purposes of car traction than any other engine we know of, and in order to get this momentum of a small armature for the purpose of moving a heavy car it would only invariably bring about the result of a jerk which we have none of us noticed so far in the actual tests and experiments made. I have failed to see it. I have noticed particularly in regard to the cable cars that it is very disagreeable for obvious reasons, but where we are using a ten horse-power motor weighing seven hundred or eight hundred pounds for the purpose, and the armature of which is but a fraction of the weight, the momentum there can amount to very little in a car weighing six tons, and I doubt whether any continued observation on his part would bring about the support of his theory.

Mr. RECKENZAUN: On the very first car which I constructed in 1882, which was worked by storage batteries, I used the momentum, not only of the armature of the motor but also the momentum of a fly-wheel which weighed between three and four hundred weight. I put the fly-wheel upon the counter-shaft and I used a gearing with discs and a wedge-shaped band. I employed the friction clutch and I thought that by starting the motor to its full speed and with a heavy fly-wheel that that would be a great advantage in the starting of the car; but I was greatly disappointed. The car started with a jerk, and when I did away with the fly-wheel I found that the car started with the greatest of ease, and I believe from actual experience which I have had in this direction that it is far better to start without the momentum of the armature or the momentum of

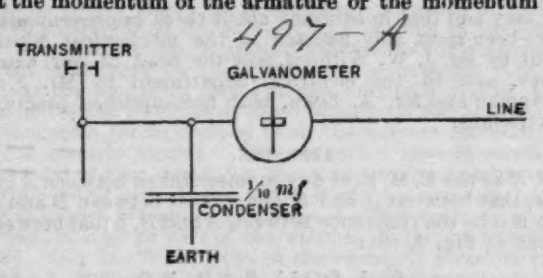


FIG. 3.—FAST-SPEED TELEGRAPHY.

any part connected with the armature. It is perfectly natural that an electric motor must start gradually. Take the motor off the car altogether and put it upon a table and send through it any current from any battery you like or from any source of energy you like—fifty volts, one hundred volts or five hundred volts—and you will find that the armature cannot start suddenly. It must take a few seconds to get up its speed, and therefore it is perfectly natural that a car propelled by electric energy must start gradually. It is a perfectly natural consequence.

I have been exceedingly interested in the various remarks which have been made to-night, and I must own that I have learned a great deal. With regard to the general application of electricity to street car propulsion, as Mr. Pendleton has pointed out very forcibly, there is a very great future in store for us, and the time is very near when horses on street cars will be entirely abandoned. We have, I might say, almost passed the experimental stage and we are now entering the more profitable stage of manufacturing and supplying street railways with electric motors. The advantages in electric motors are not only economy but cleanliness and great saving of space at the depots and great saving of space in the streets. If you take crowded streets like Broadway, New York, and many other thoroughfares where every square inch of space in the street, you might say, is of value, and do away with horses, you save in length about twelve feet, and in width, of course the width of the track. Now it would seem ridiculous for me to make such a remark, but if there are hundreds of cars running in a crowded street it makes many thousand square feet of space saved and in that space other vehicles can pass. Another great advantage in electrical propulsion will be (apart from economy which is certain to be a result) that we shall be able to travel at a greater speed. Horses cannot pull a car at a greater speed than six miles an hour. The average speed of all the horse-cars in America and Europe is five miles an hour including stoppages. Now, if we can travel at the rate of eight or ten miles an hour, a great deal of time will be saved and passengers will avail themselves more of the new mode of traction. They will save a great deal of time. The traffic is constantly increasing. I have heard recently that the street-car traffic of New York alone has increased in the last ten years fifty per cent. If it increases in the next ten years another fifty per cent. it would be impossible to cope with the traffic at all if we employ horses. The elevated railroads, it appears, are doing a large amount of business, almost as much as they are capable of doing, and the only loophole, it seems to me, out of the difficulty is either by building underground railroads or by propelling the street cars at a greater speed, so that the same number of cars will carry double the number of passengers in the same time. With these remarks, gentlemen, I close, and I thank you very much for your very kind attention. (Applause.)

Mr. WHEELER moved a vote of thanks to Mr. Reckenzaun for his interesting and instructive paper. This was carried unanimously.

Fast-Speed Telegraphy.*

BY WILLIAM HENRY PREECE, F. R. S.

In this Jubilee year of telegraphy many papers have been read, articles written, and speeches delivered on the progress made during the past 50 years, scientifically, practically and commercially, but with very few exceptions has any justice been done to the advance made in England in the scientific direction.

Sir William Thomson said, "You have told us how splendidly the land telegraphs are worked; you have pointed out how admirably under the influence of the government system the application of science to telegraphy has been developed. Under government management within these last seventeen years the applications of science to telegraphy have not stood still, but, on the contrary, have been pushed forward with every possible energy and with the most marvelous success."

I want to describe the evolution of the system of high-

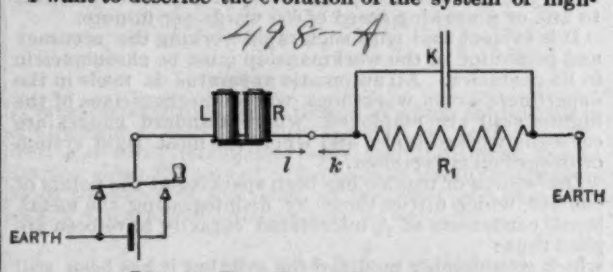


FIG. 4.—FAST-SPEED TELEGRAPHY.

speed tylegraphy since it left the hands of Wheatstone and Mr. Stroh.

The following table illustrates the progress made:

Year.	Words per minute.	Speed to Ireland.
1870	80	50.3
1875	100	70
1880	200	150
1885	350	250
Now	600	462

These results have been the consequences of—

1. Greater perfection of apparatus.
2. The elimination of electro-magnetic inertia.
3. The improvement of circuits.
4. Introduction of high speed repeaters.

Two reasons exist why these great advances have not received notice; they were not patented, and they emanated from government service. A patent has certainly one great use, it fixes a date and it defines an invention, but it also attracts attention to novelties and improvements, and if the patent be lucrative it incites the immoral to try and do the same thing in another way, which tends to litigation, though often results in still further improvements. There is a very ridiculous conception abroad and widely circulated, that commercial enterprise alone is competent to excite inventive skill. I have more than once contested this proposition, but with very little effect, for from the floor of the House of Commons, and from the columns of the press, there is the same cold indifference to the work done in government departments, and the same cry as tersely put by *Nature*, "The feeling is, 'What good can come out of Nazareth?'"

A complete set of automatic instruments consists of:

1. The *perforator*, which punches a strip of paper with holes on the principle of the Jacquard loom, so as to regulate the number, order, and rate at which alternate currents of electricity are sent along a wire by

2. The *transmitter*, which is the automatic part of the apparatus, sending along the line those currents which at the distant end are recorded as words in the form of dots and dashes, replacing the slow and uncertain manipulation of the hand.

3. The *receiver*, which is an ink-writer of extreme delicacy and great rapidity, recording the words in the Morse character.

1. The perforator has not been much modified since it left the hands of the accomplished mechanician, Mr. Stroh. Experience has brought out several mechanically weak points, which have been much simplified and strengthened. They have been made to standard gauge,

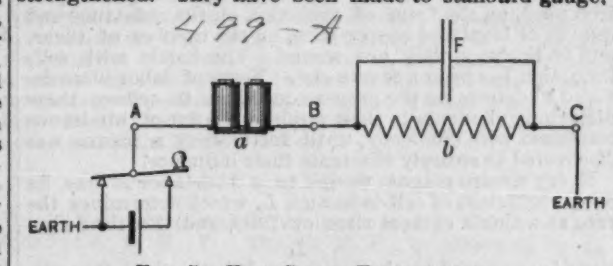


FIG. 5.—FAST-SPEED TELEGRAPHY.

both as regards the number of perforations per foot,† the strength of springs, and the uniformity of parts, so that interchangeability is possible throughout the whole service. The fact that air pressure for working pneumatic tubes exists in many large post-offices besides London has led to its application to punching, which is rather a severe mechanical labor, and it has rendered it possible, by constructing double-banked perforators, to punch eight slips at one time, an invaluable reduction of labor in the transmission of news, which has grown to such gigantic proportions that frequently over 1,000,000 words have been sent in one evening from the Central Office in London.

2. The transmitter is an instrument designed to send as many reversals of current per second through the line as the retardation and the electro-magnetic inertia of the circuit will allow. These reversals are rapid alternations of positive and negative currents, the former making dots and called the marking currents, the latter making spaces and called the spacing currents. When the transmitter runs free without any paper to guide it, these currents flow through the line with a regular frequency which is controlled by a beautiful eccentric governor invented by Mr. Stroh. This frequency in the present transmitter can be regulated from 14 up to 240 reversals per second, which means 600 words per minute.

When unpunched paper is inserted a permanent current goes to line, the motion of the electrical contract that re-

* Read before the British Association, Manchester, Sept., 1887.

† The standard is 120 centre perforations per foot, or, counting the first and last perforation, 121 centre perforations per foot.

verses the current is checked or hindered; when the paper is punched then a dot means a complete reversal, a dash means three complete reversals, but the middle one checked by the paper; a space means three complete reversals all checked by the paper. In the earlier form of transmitter the reversal was effected by a commutating arrangement which involved time, and which could not exceed a frequency of 48 or 120 words per minute. It was a very rapid double current key using one battery. In 1883 this plan was revised, a double or divided battery was used, Fig. 1, earth being in the centre, the contacts being simple butt contacts.

The mechanism was thus very much simplified, and the possible speed of working increased to a frequency of 120 or 300 words per minute. Subsequently, in 1886, the divided battery was rendered unnecessary by a new form of contact of the same character, but requiring only one battery, Fig. 2, and the possible frequency was increased to 240, or a working speed of 600 words per minute.

It is evident that with such rapid working the accuracy and perfection of the workmanship must be chronometric in its character. All automatic apparatus is made in the department's own workshops, where mechanicians of the highest skill are employed, where standard gauges are carefully worked up to, and where the most rigid system of inspection is exercised.

One source of trouble has been sparking at the points of contact, which dirties them by disintegrating the metal. Small condensers of $\frac{1}{10}$ microfarad capacity have been applied thus:
which considerably modified the evil; but it has been still further reduced by switching out the galvanometer while the transmitter is at work, for sparking is principally due to the presence of electro-magnetic inertia in the apparatus.

3. The receiver has been entirely remodeled both mechanically and electrically. The principal mechanical improvement has been replacing a spring as a motor by a weight in order to secure a more rapid and more uniform rate of running at high speeds, and as a receiver may at one moment have to record at 400 words per minute and the next at 25 when working by hand, it is clear that unless some governor be used the waste of paper would be excessive.

Improved flies have been applied to Stroh's eccentric governor so as to make it act with equal efficiency at the present high speeds. Thus, the length of the signals made and the length of paper used per twelve words is practically the same at high and low speeds.

It was thought at one time that the speed of working was limited by the retardation of the line circuit, but a careful inquiry into the phenomena of electro-magnetic inertia (*Journal* of the Society of Telegraph Engineers, 1877. Vol. V., page 27) led me to the conclusion that the principal source of slowness was in the electro-magnet. It is not possible, owing to this electro-magnetic inertia, to establish *instantaneously* through a circuit containing an electro-magnet a current of the strength due to the electromotive force producing and to the resistance regulating it. The current strength can be brought up only gradually to its proper value.

Every electro-magnet in a telegraph wire becomes an obstruction to the flow of currents, especially when these currents are rapidly intermittent or rapidly reversed. In telegraphs they lower the speed of working, in telephones they blurr the clearness of articulation. It is as though the passage for the flow of electricity were restricted, as the clear way of a water pipe would be choked by the presence of a large stone in the pipe, or the efficiency of a gas pipe would be reduced by its being crushed in by a blow from a hammer. But the peculiarity of the electro-magnet is that the currents themselves cause their own hindrance, and the more frequent they are the greater the throttling or choking action. The action is not dissimilar to that of the throttle valve of a steam engine actuated by a centrifugal governor. Hence, Lord Rayleigh has lately proposed to apply the term "throttling" to this peculiar effect of electro-magnetic inertia. Every electro-magnet has thus a time constant which determines the rate beyond which it can not work. This time constant can be obtained only by experiment, for it depends on the quality and quantity of iron used, on the form of the core, on the resistance and quality of insulated copper wire, on the number of turns, and on the way they are wound. The battle with self-induction has been a severe one. Years of labor were devoted to determine the proper conditions to reduce these disturbing elements to their minimum point of hindrance combined with efficiency, until fortunately a means was discovered to entirely eliminate their influence.

Every electro magnet wound to a resistance R has its own coefficient of self-induction L, which determines the rate at which a current rises or falls, and the time constant is expressed by the ratio $\frac{L}{R}$. It is the time the current takes to rise from zero to its full value.

If the two plates of a condenser of capacity K be shunted by a wire of resistance R_1, then when a current flows the condenser will be charged and the current will consequently gradually rise to its full value, and if the current stops the condenser will discharge and the current will in the same way gradually fall to zero. The time constant of such a condenser is $K R_1$. This is exactly the same kind of action that takes place in an electro-magnet, and by properly regulating the size of the condenser and the amount of resistance the one can be made to exactly reproduce the former.

Now, if we connect up an electro-magnet and a condenser in the way shown in the diagram, Fig. 4, then, whenever the main current ceases, there is an electromotive force in the magnet due to L, tending to prolong the current in the direction (l), while there is an E. M. F. in the condenser K due to the charge tending to do the same thing, but in the opposite direction (k). Hence, these two effects oppose and neutralize one another when the resistances R and R_1, the coefficient L, and the capacity K are properly adjusted.

Maxwell has shown that when an electro-magnet and a condenser are balanced in a Wheatstone bridge, $L = R R_1 K$, but in the shunted arrangement (as shown in appendix),

$$L = R_1{}^2 K.$$

The introduction of the shunted condenser has had the most marvelous effect on the speed of working. It has entirely eliminated any hindrance caused by the electro-magnet, and now the only cause of slow working is the mechanical efficiency of the apparatus and the condition of the circuit. I have pointed out in another paper how copper wire has removed electro-magnetic inertia from the wire, and there remains only the retardation ($K R$) of the circuit to check speed of working.

Four hundred and fifty words a minute is now obtained with ease on circuits of 200 miles in length, and we have on some circuits reached 600 words per minute; but 450 is more than we can practically cope with, and, therefore, at present the apparatus exceeds in efficiency the capacity of the staff; but this speed rapidly falls off as the retardation of the circuit increases, and while we can work at the highest speed between London and Leeds, we can only get one-fourth of this speed to Glasgow. If, however, we place at Leeds a repeater, which will respond to and relay on these frequent currents, we ought to get the maximum speed to Glasgow, and this is done by the high-speed repeater. The high-speed repeater contains on one board all the electrical functions of two transmitters and two receivers. All causes of hindrance are removed from it, and it works at the highest possible speed. Electrically it is an exceedingly complicated piece of machinery. It owes its efficiency to the perfection of the Post Office standard relay—a relay which has practically no time constant, which responds to exceedingly delicate currents, and which makes perfect electrical contacts—and to the use of condensers, Fig. 3.

The repeaters are very extensively used. There are special relay offices at Haverfordwest, Nevin and Anglesey to provide full speed to Ireland. The speed to Ireland in 1870 was 50 words per minute. It is now 462 words—a ninefold advance. Leeds, Manchester, Bristol and Preston have also special relay rooms. There are 101 repeaters in use. Some circuits, such as those to Aberdeen, have two repeaters in circuit, one at Leeds and the other at Edinburgh. In fact, these high-speed repeaters enable the highest possible speed of working to be obtained to every part of the United Kingdom. They are arranged so as to be used at will either for automatic or for ordinary key apparatus, and either for simple or for duplex working under each class of working.

The introduction of high-speed repeaters and the use of shunted condensers have marked epochs in the evolution of telegraphy as eventful as the introduction of duplex working or of the telephone. The various stages of improvement which have been narrated in this paper would each form the subject matter of a patent were it the habit in the government service to patent. Had the telegraph service been conducted under the severe competition of private enterprise, each form of transmitter and of receiver, the relay, the high-speed repeater, the shunted condenser, and every other improvement would have been patented, and would have been found worthy of substantial reward.

I may add that in bringing about these improvements I have been most ably assisted in the mechanical department by Mr. J. W. Willmot, now the head of our workshops, and in the electrical department by Mr. J. B Chapman and Mr. A. Eden, both accomplished practical electricians.

APPENDIX.

If E be the E. M. F. at any moment taken between A and C, e_1 that between A and B, and e_2 that between B and C, also if a be the resistance between A and B, b that between B and C, Fig. 5, then

$$E : e_1 :: a + b : a$$
$$E : e_2 :: a + b : b$$
$$e_1 = E\frac{a}{a+b},$$
$$e_2 = E\frac{b}{a+b}.$$

The quantity in condenser is

$$Q = e_2 F = E F\frac{b}{a+b},$$

and that discharged from condenser through a is

$$q_1 = Q \cdot \frac{b}{a+b} = E F\frac{b^2}{(a+b)^2}.$$

Again, the quantity discharged from the magnet is

$$q_2 = L\frac{E}{a+b} \cdot \frac{1}{a+b} = E L\frac{1}{(a+b)^2}$$

But $q_1 = q_2$

$$E F\frac{b^2}{(a+b)^2} = E L \cdot \frac{1}{(a+b)^2}.$$
$$\text{or} \qquad F b^2 = L.$$

Underground and Aerial Cables.*

BY B. E. SUNNY.

A mile of Patterson cables has been put down in West Madison street in Chicago, made up of one 150 wire cable and cables of from 25 to 125 conductors, containing in all about 200 miles of wire. Number 18 American gauge was used and the insulation and capacity tests are very satisfactory.

These cables were put down to abandon a pole line of 90 wires built about six years ago. Notwithstanding the fact that the wires on the route were badly decayed and contained many defective connections, and that the cables were of the best manufacture, the wires on the pole route talked about 25 per cent. better than those in the cables.

The cross talk is only noticeable at times, and is not heavy. These cables are laid in a box of creosoted wood and covered with one-quarter inch tarred sheet-iron. The box is just big enough to take the cable and no filling of any kind is used. A gang of twenty men put this cable down at a rate of 500 feet per day, finishing up everything excepting the permanent restoration of the pavement. Eleven hundred feet of conduit has been built to carry the cables from the present central office to the new building. The construction includes the use of wrought-iron pipe two and one-half inches inside diameter, free from burs and presenting a smooth surface to the cables. The pipes, sixteen of them in all, are spread apart and the interstices filled with concrete. We are putting No. 18 gauge 200 conductor cables into the pipes, and find that they work smoothly, and that a gang of six men can put in four pieces of cable 400 feet each per day. The underground cables put down two years ago are giving satisfaction. Recent tests on some of them show an insulation ranging from five to fifteen megohms. One cable put down by the Standard Company two years ago indicated a very low insulation on the regular test. We opened the street in two or three places and finally located the fault in a splice. No abrasion of the lead pipe could be noticed nor was there any superficial evidences of a fault. A piece including the splice was cut out and another piece of cable put in. The piece cut out was laid on a board and shortly it was noticed that water was coming out of the splice through a blow hole the size of a pin in the solder. There was perhaps half a pint of water in the sleeve. It took two years for the fault to develop. In another instance a Standard cable was cut into by plumbers some time last November. In June the insulation was found to be low and when the fault was located it was discovered that the water had gone into the core through a bad cut in the lead and had worked back forty feet, requiring new cable to that extent. We have several cables, chiefly aerial, that are defective and are being looked up. It requires the constant attention of a galvanometer corps to keep them in good shape. By means of semi-annual tests defects have been discovered and removed before they had time to affect the service. The trouble from low insulation at the terminals is being overcome by filling the terminals with paraffine wax or some other insulator, and keeping the terminals well protected from moisture. The trouble outside of the terminals on air cables is made up of cuts in the lead by hooks cutting through, bullet holes and careless workmen.

The following tests recently made may be of interest: Two wires were selected which ran together through nine cables of seven different styles, a distance of 4.4 miles. The cables are Patterson aerial and underground and Standard aerial and underground, and contain from 50 to 150 wires, each ranging from eighteen to twenty-six gauge. The resistance measures 444 ohms. The first test was made on a day of alternate sunshine and rain, when everything was damp. There was absolutely no cross talk from one wire to the other, and conversation could be carried on freely and without any more effort than on an air line. The introduction of an annunciator drop into the circuit made no difference. A test for insulation showed 400,000 ohms for the distance and a static capacity of 1.4 microfarads. A week later the same wires were used in the same manner with less satisfactory results. The weather was dry and warm. It was found that counting on one could be distinctly followed on the other and vice versa.

The cross talk from the other wires was very noticeable, but not of sufficient volume to disturb the user. Conversation at a distance of eight inches from a fairly adjusted transmitter was indistinct and muffled. With the lips close to the transmitter, and by speaking in the usual tone of voice, the results were fairly satisfactory. This was particularly true when an air line of one and one-half miles was added. The measurements made after the test showed the insulation to be 4 megohms for the distance against .4 of a megohm on the previous test, and 1.15 microfared capacity against 1.4. By opening one of the wires at both ends, so that all connection with the earth was removed, conversation could be freely carried on between three parties who were looped in. The first one was 5,000 feet from the open end of the cable, and the other 12,000 feet. The only difference noted by the intermediate parties in the working of the wires with the ends open was that the cross talk was much heavier than with the grounds on. The second test indicates conclusively that we have used up all of our margin, and that a slight addition to the length of the cables will make the connection of no commercial value. In fact, in ordinary dry, clear weather, conversation is only carried on by frequent repetitions and considerable discomfort. The nine cables included in this test are all in good condition, and with the exception of a few pieces of air cable, are new. On the above circuit there are sixteen terminals in use, but in all cases, except in exchange offices, the cable wires of one cable were connected with those of another at the terminals with kerite or okonite wire, so that the insulation was good at these points. The experience of four years has proven the fallacy of the practice of requiring the manufacturers to furnish a cable showing an insulation of from 300 to 800 megohms per mile. While this insulation can be secured immediately upon the completion of a cable, it if utterly impossible to maintain it. Nor is it desirable to maintain it, for the reason that cross talk is greater on a cable with a "fancy" insulation than in one of a megohm. Subscribers always complaint of cross talk when their wires are put into a new cable, but after a few months we hear no more about it. This is not so much because they have become accustomed to the cross talk as it is that with the lowering of the insulation the cross talk is decreased. A better specification would be one megohm per mile and not more than five, and a guarantee from the manufacturer that this insulation will hold up for ten years. Such an insulation exceeds anything that we are able to get on air lines. In a recent test nine wires showed each an insulation of 5.3 megohms. Rain began to fall, and in ten minutes the insulation had fallen off to 3.2, and no doubt went lower. This illustrates the extreme sensitiveness of a high insulation to moisture and indicates clearly that where there is a large number of cables in use the conditions are constantly varying, and nothing like uniformity in the working of the wires can be expected or secured.

* Read before the National Telephone Exchange Association, Pittsburgh, September 27, 1887.

Aluminum Iron Alloy.—The Cowles Electric Smelting and Aluminum Company, of Lockport, N. Y., whose iron aluminum alloys are now in general use by our steel works in making steel castings, has recently received from Germany an order for five tons of ten per cent. aluminum iron alloy containing about 1,000 pounds of aluminum.

A New Automatic Fire Alarm.—The National Automatic Fire Alarm Company, of Buffalo, N. Y., has been incorporated with a capital stock of $100,000. The president is J. W. Tillinghast; vice-president, P. P. Burtis; secretary and treasurer, J. A. Pferd, who are directors with J. W. Frost and J. Tillinghast. The company will at once enter upon the business of installing fire alarm thermostats, etc.

The Dip of the Magnetic Needle.—Mr. G. A. Rowell, of Orford, England, has just published a pamphlet on atmospheric electricity and the causes of the changes in the inclination of the magnetic needle. The author attempts to demonstrate that the magnetic poles of Europe and America coincide with the centres of the greatest cold upon the two continents. He attributes the shifting of the magnetic poles to the same series of astronomical and geological phenomena that produces the secular changes in climate. This theory, he adds, leads us to the not very agreeable conclusion that our winters will be prolonged and will increase in severity, since the magnetic inclination keeps on diminishing.

The General Theory of Dynamo Machines.*

BY EDWARD HOPKINSON, D.SC.

Using the term "dynamo" in the widest possible sense, including under it all machines for the conversion of mechanical forms of energy into electro-magnetic, and electro-magnetic into mechanical, there are certain characteristics common and essential to all types of such machines, whether they be known as magneto machines, alternate current machines, or continuous current machines, either compound, shunt, or series wound, and of the drum, ring, or disc type. It is therefore possible, up to a certain point, to construct a theory of dynamo machines which is perfectly general in its application. The object of the present paper is to trace briefly the outlines of such a theory, and to indicate how the consideration of specific types of machines can be developed therefrom, and in what direction research is required to elucidate some points still obscure. A dynamo consists essentially of two closed circuits or "tubes," in both of which there is a displacement of the nature of a flux dependent upon the relative motion of the two circuits. We may call one of these the "magnetic circuit" and the other the "electric circuit." Either or both of these may be in motion; but as we are concerned only with the relative motion of the two, we may for convenience (as, in fact, is usually the case) regard the magnetic circuit as fixed, or displaced only by the reaction of the electric circuit upon it, and consider the latter only as moving under external forces, whether electric or mechanical. The flux along the magnetic circuit is called the "magnetic induction," which is a vector or directed quantity, requiring for its definition reference to co-ordinate axes. It is subject to the fundamental condition known as the "solenoidal condition," or "equation of continuity," which may be expressed in words "that the flux across all sections of the tube is the same," or otherwise "the induction through any surface bounded by a closed curve depends only on the form and position of the closed curve, and not on that of the surface itself." The flux along the second circuit is called the "electric current," and is also a vector quantity, subject to the solenoidal condition. Neither circuit is necessarily bound by the limits of the machine, and both may be and generally are, subdivided. Both these fluxes are produced by corresponding forces, called respectively "magnetic force" and "electromotive force," which likewise are vector quantities, but are defined by reference to a line instead of by an area, as is the case with the fluxes. (Maxwell. Treatise on Electricity and Magnetism, Vol. I, page 10.) The solenoidal condition for magnetic induction is a direct deduction from Coulomb's original experiments, verified by all subsequent observations in magnetism. We now require to know the relation between each force and its corresponding flux. Let us first inquire into the relation between the magnetic induction (B) and the magnetic force (H). Such a relation may be expressed by the general equation

$$B = f^{-1}(H).$$

The form of the function depends upon the medium in which the tube is drawn, and also the physical conditions of the medium. For air and all other gases, and generally for all substances classed as "non-magnetic," it is a linear function possessing one coefficient or constant only. For such substances the equation may be written

$$B = \mu H.$$

Since the scalar part of H, *i.e.*, the numerical definition of H, is at our disposal, we may so define H that μ is unity for all the substances above referred to, and write

$$B = H.$$

For iron, and generally for all magnetic substances, H is not a linear function of B, and its expression will involve several constants depending upon the medium, and such physical conditions as temperature and strain, and its previous history. The determination of the form of the function for iron in particular has been the subject of a great number of experiments, but no general expression has yet been discovered, and it has usually been found most convenient to record the experimental results in the form of a curve referred to rectangular axes, in which the ordinates represent magnetic induction and the abscissæ magnetic force. Such curves have been fully investigated for iron of various composition, and under varying physical conditions, among others particularly by G. Wiedemann (Die Lehre vom Galvanismus, Vol. II., page 840, and sequor), Rowland (Phil. Mag., Aug., 1873), Carl Barus and Vincent Strouhal (Buletin of the United States Geological Survey, M. 14, 1885), J. Hopkinson (Philos. Trans. of R. S., Part II., 1885), J. A. Ewing (Philos. Trans. R. S., Part II., 1885, and Part II., 1886, and Proc. of R. S., Vol. XLII., page 200, 1887). By reference to these memoirs it is now possible to construct the curve with fair accuracy for iron of any known composition. For convenience we may express the curve by the equation

$$B = \mu H.$$

μ is then the tangent of the angle which the tangent to the curve makes with the axis of x. It has received various names: by Sir William Thomson, "permeability" (Reprint of Papers on Electricity and Magnetism, Vol. II., page 54); by Maxwell, "coefficient of magnetic induction" (Treatise on Electricity and Magnetism, Vol. II., page 54); and again, "magnetic inductive capacity" (Vol. II., page 243).

Secondly, we require to know the relation between the E. M. F. and current. This is well known to be expressed by a linear relation, known as Ohm's law, involving one constant coefficient only, universally designated as the "resistance."

$$E = R C,$$

E being the E. M. F., and C the current. As far as all experimental evidence goes, R and the reciprocal of μ possess the same two characteristics, viz., that for any given substances in any defined physical condition they are proportional to the length of tube considered, and inversely proportional to its cross section: μ may therefore without impropriety be called the reciprocal of the "magnetic resistance," but as expressing this analogy only. It must be distinctly remembered that for magnetic substances there is no such relation as Ohm's law.

* Read before the British Association, Manchester, September, 1887.

Having now defined the relation between the fluxes and their corresponding forces, it remains to consider the relation between the fluxes themselves, dependent upon the relative motion of their circuits. This may be expressed in various ways, all of which are the expressions of Faraday's well-known law. (i.) The line integral of the E. M. F. round the electric circuit is the rate of decrease of the surface integral of magnetic induction through any area bounded by the circuit; or (ii.) the time integral of the total E. M. F. round the electric circuit together with the surface integral of the induction through the circuit is a constant quantity. Again, since the surface integral of any vector over any surface which satisfies the solenoidal condition can be expressed by a line integral round any closed curve bounding the surface, a new vector may be introduced called the "vector potential" of magnetic induction, which is such that its line integral round any circuit is equal to the surface integral of induction over any surface bounded by the circuit. Also, the time integral of the E. M. F. in any circuit is the electro-magnetic momentum. Hence, Faraday's law may be expressed: (iii.) The electro-magnetic momentum of a circuit is the line integral of the vector potential round the circuit. (Maxwell, Vol. II., pages 28 and 234.)

Excluding for the moment the consideration of magneto machines with permanent magnets, and of machines in which iron plays no part whatever, we may more particularly consider that class of dynamos in which the magnetic field is produced by the use of iron excited by a current; and we then require to know the relation between the current and the induction in the magnetic field produced by the current. Faraday showed that the magnetic field in the neighborhood of an electric current is the same as that of a magnetic shell bounded by the circuit of the current, and has therefore a similar magnetic potential. This is expressed by saying (iv.) that the line integral of magnetic force round any closed curve is zero, provided the closed curve does not surround the electric current, and if the current passes through the closed curve, then the line integral is proportional to the number of times it passes through, and is equal to $4\pi n c$, where c is the current and n the number of times it passes through the closed curve.

If we take the magnetic units as fundamental the propositions (i.) and (iv.) define the units of E. M. F. and current. On the other hand, if we start with the arbitrary units of E. M. F. and current, based on quite other considerations, the propositions define the units of magnetic induction and magnetic force in terms of these.

We have now the materials for a complete investigation of a dynamo of any given configuration and constructed of iron, whose magnetic qualities are known. It is required to determine the E. M. F. and current in the electric circuit, as its configuration relative to the magnetic circuit is changed by the application of external forces, and as the magnetic forces in the magnetic circuit are changed either by external electro-magnetic forces or electro-magnetic forces derived from the current circulating in the electric circuit. The magnetic circuit consists in general of four parts: (i.) The magnetic limb, which is surrounded by coils of wire, through which the exciting current is passed, which may be derived either from external sources, or may be part of the electric circuit of the machine. (ii.) The field pieces, or the extended polar extensions of the magnet limb, embracing the armature. (iii.) The air space being the necessary interval between the iron of the pole pieces and the iron of the armature, or in cases where the armature contains no iron, the interval between the opposed pole pieces. This interval may be an entirely free air space or partially occupied with other non-magnetic matter, according to the particular type of machine. (iv.) The armature, or that part of the machine carrying that portion of the electric circuit which is subject to displacement under external forces. There may be other subsidiary portions of the machine, *e. g.*, the magnet limb may be divided into one or more portions connected by yokes, but as these may be treated in exactly the same way as the pole pieces, they do not require special consideration. Again, the magnet limb may be divided so as to form several magnetic circuits, each of which may be considered independently. In alternate current such subdivision is universal, and is not infrequent in continuous current machines.

The magnetic circuit is thus subject to magnetic forces due to the current in the armature and the current round the magnet limb. We must therefore, in the general case, take these as the two independent variables, which we may denote by C and c. Now, it may be assumed with sufficient accuracy that in the magnet limb the boundaries of the tube of magnetic induction are coincident with the boundaries of the iron, and the cross section of the tube the same as the cross section of the iron. Outside the limb a portion of the lines of force will complete a magnetic circuit through external space, and will not enter the pole pieces. The extent of this leakage or induction, from which no useful effect is obtained, depends upon the configuration of the machine and the degree of saturation of the iron, and could be calculated therefrom; but as it can be experimentally determined for any machine with great ease, it is unnecessary to consider it further, and we may regard the total induction in the magnet limb as greater than the induction in the pole pieces in a constant ratio, which we will denote by V_1. It is usual to construct the pole pieces of large section compared with the magnet limb, and hence the section of the pole pieces may again be taken as the section of the tube of induction; but as the lines of force leave the pole pieces to cross the air space, we cannot ascribe any boundary to the tube, but in every machine a portion only can pass through the armature, and part must pass from one pole piece to the other by lines external to the armature. Moreover, the relation between the two parts will not be a constant one, unless the magnetic forces in the armature are constant, which can never be the case. It is therefore necessary to consider the tube of induction, which crosses the air space and enters the armature, as a variable portion of the whole tube, the variation depending upon the magnetic forces in the armature. We may denote the ratio of the induction through the pole pieces to the induction through the armature by ν_2. Knowing now the components of the magnet circuit, we can find the magnetic forces in the several parts, and hence obtain the induction in the tube. Let A_1 be the cross section of the magnet limb; l_1 its length; A_2 the cross section of the pole pieces; l_2 the mean length of the tube therein; A_3 the cross section of the air space, comprising all the space through which the lines entering the armature pass; l_3 its length; A_4 the cross section of the iron of the armature (if it contains iron), and l_4 the mean length of the tube of force therein. Then the line integral of magnetic force taken round the circuit is:

$$\frac{1}{\mu_1} l_1 \frac{\nu_1 \nu_2 I}{A_1} + \frac{1}{\mu_2} l_2 \frac{\nu_2 I}{A_2} + \left(\frac{1}{\mu_3} \frac{l_3}{A_3} + \frac{1}{\mu_4} \frac{l_4}{A_4} \right) I$$

the μ's being the coefficients of magnetic induction for the several portions of the circuit. For air the coefficient is unity, hence $\mu_3 = 1$. I is the total induction in the armature, which is assumed to be uniformly distributed over the tube. The integration has extended along the tube only which passes through the armature, and hence the forces along the portions of the whole tube which pass outside the machine do not appear. Now, the magnetic circuit is cut by the current in the magnet coils and the current in the armature. Let n_1 be the number of times it is cut by the former, n_2 by the latter. Then

$$\frac{1}{\mu_1} l_1 \frac{\nu_1 \nu_2 I}{A_1} + \frac{1}{\mu_2} l_2 \frac{\nu_2 I}{A_2} + \left(\frac{l_3}{A_3} + \frac{1}{\mu_4} \frac{l_4}{A_4} \right) I = 4\pi (n_1 c + n_2 C).$$

It must be noted that the direction in which the circuit is cut by c and C is in both cases taken to be positive. Referring to three rectangular axes and measuring the induction along the axis of z, the current round the magnets along the axis of x, and that in the armature along the axis of y, the above equation may be written

$$l_1 f_1 \left(\frac{\nu_1 \nu_2 z}{A_1} \right) + l_2 f_2 \left(\frac{\nu_2 z}{A_2} \right) + l_3 \frac{z}{A_3} + l_4 f_4 \left(\frac{z}{A_4} \right) = 4\pi (n_1 x + n_2 y)$$

This represents a surface the ordinate at any point of which is the induction through the armature. Such a surface was first described by Dr. John Hopkinson (lecture before the Institute of Civil Engineers, April, 1883), and is called the "characteristic surface." It must be remembered ν_1 is a constant coefficient, or may be taken as such with sufficient accuracy, but ν_2 is not constant. It is unnecessary to consider further its general form, as it may better be determined in connection with the particular type of machine under consideration. f_1 f_2 f_4 would be the same functions if the quality of the iron were the same in the several portions of the machine.

Having obtained a general expression for the induction in the armature, the E. M. F. in the electric circuit, when it is displaced, can be deduced by Faraday's law.

Consider now the application to alternate current machines. Such machines are usually multipolar. In machines of the disc type the number of poles is even, and the armature is divided into segments corresponding to the number of poles, and revolves uniformly between them. The tube through any one pair of opposed poles and back through another need only be considered, and the total effect of the machine obtained by summation therefrom. Suppose the iron of both magnets and armature so arranged that no currents are induced therein. There is then only one electric circuit to deal with. The whole current in one section of the armature cuts the magnetic tube passing through the segment, as many times as there are convolutions. Let m be the number of convolutions. The current x round the magnets is usually derived from independent sources, and maintained constant. For each such constant value the characteristic surface becomes a curve giving the relation between the induction through the armature and the current in it. The areas A_1, A_2, and A_4, and the lengths l_1, l_2, l_3, and l_4 are constant, but the area A_2 is a periodic function of the time, and can be expressed by a series of cosines, the coefficients of the series being determined by Fourier's theorem from the dimensions of the machine. The general consideration of the form of ν^2 has been worked out by Dr. J. Hopkinson (Proc. R. S., 1887), and need not be referred to further. The induction is a function of the time, but as an example consider its value at that epoch when the cores of the armature are exactly opposed to the pole pieces.

$$\frac{l_1 \nu_1 \nu_2 I}{\mu_1 A_1} + \frac{l_2 \nu_2 I}{\mu_2 A_2} + \left(\frac{l_3}{A_3} + \frac{l_4}{\mu_4 A_4} \right) I = 4\pi n_1 c - 4\pi m C$$

Since the coefficients are all determinate by measurement or experiment, I is obtained in terms of c and C. Assume that, instead of continuous rotation of the armature, the action of the machine is such that each core of the armature is moved periodically in an infinitely short time from between one pair of poles to the next. Let T be the periodic time, E the E. M. F., then

$$E = m \frac{2\pi}{T} I.$$

Hence E is determined in terms of c and C. E is here the maximum E. M. F. The E. M. F., as measured by a Cardew voltmeter or equivalent instrument, will be $\frac{1}{\sqrt{2}}$ of the maximum. If the equation of the characteristic be differentiated with regard to the time, we shall obtain an equation of the form

$$A \dot{y} + B y = \text{periodic function of } t,$$

when B is constant and A is a periodic function of t, but usually assumed to be constant, and called the "self induction" of the machine. In the case of an alternate current machine there are usully other magnetic forces acting upon the electric circuit external to the generating machine. For instance, the electric circuit may contain a transformer or a second machine inserted as a motor or an arc lamp in which there is a constant E. M. F. changing sign with the current. It is not then sufficient to consider the magnetic tube within the machine only, but the effect of all other tubes which are cut by the circuit must be included, and the characteristic surface of the whole system obtained by summation. These cases have been worked out, taking A as by Dr. J. Hopkinson. ("Journal of Tel. Engineers," 1884.)

Now consider the application to continuous current machines. It is obvious that no current continuous in direction can be obtained by continuous rotation of any part of the electric circuit, unless arrangement is made for reversing the current at a certain stage of each revolution. If the rotating part contained one section only, the current, though continuous in direction, would oscillate from zero to its maximum. To avoid this the electric circuit is divided into a number of sections, arranged symmetrically on the armature, the current in one or two of which only is reversed at a time. If the number of sections be even and equal to $2m$, one half will be in series, and one half the total current will pass through each half, except at the instant of commutation. At such time two sections are short

circuited, and form complete circuits in which the current will be determined by the induction through them at the time; and the number of sections in series will be $\overline{m-1}$. If the number of sections be odd and equal to $\overline{2m+1}$, one section only will be commuted at a time, and at that instant there will be m sections in series. At other times there will be $\overline{m+1}$ sections in series on one side and m on the other, and consequently there will be a superposed current flowing through the armature only, due to the inequality in the number of sections in series in the two halves. In one revolution of the armature, the tube of induction through it will be cut four times by each segment, and if the plane of the commutation is symmetrical with regard to the tube of induction the current in one half the sections will cut it in the opposite direction to that in the other half. In this case, $n_2 = 0$. But any displacement of the plane of commutation from the symmetrical position will cause the current in a greater number of sections to cut the tube in one direction than in the other. Let λ be the angular advance of the plate of commutation, and m the number of sections in the armature; then $n_2 = \frac{\lambda m}{\pi}$. The value of λ may be fixed for any given machine, or varied at pleasure, or may be determined to avoid sparking at the time of commutation of a segment. The general discussion of the value of λ to effect this has not yet been attempted. For the present λ must be regarded as independent. The general equation of the characteristic surface becomes for a continuous current machine,

$$l_1 f_1\left(\frac{\nu_1 \nu_2 z}{A_1}\right) + l_2 f_2\left(\frac{\nu_2 z}{A_2}\right) + l_3 \frac{z}{A_3} + l_4 f_4\left(\frac{z}{A_4}\right) = 4\pi n_1 x - 4\lambda m y$$

λ being reckoned positive when the displacement is in the direction of rotation.

If no current passes through the armature $y = 0$ and ν_2 may be taken as constant and determined by experiment. The equation may then be written

$$l_1 f_1\left(\frac{\nu_1 \nu_2 z}{A_1}\right) + l_2 f_2\left(\frac{\nu_2 z}{A_2}\right) + l_3 \frac{z}{A_3} + l_4 f_4\left(\frac{z}{A_4}\right) = 4\pi n_1 x$$

which is the equation to the characteristic curve of a shunt wound or separately excited machine, and determines the induction for all values of the exciting current. Having determined the characteristic when $y = 0$ the characteristic surface can be determined therefrom by considering the form of ν_2. (See J. & E. Hopkinson. Trans. of R. S., Part I., 1886, page 334.)

It has been assumed that the sections of the armature are the only conductors in the field, or that the armature is so constructed that no currents circulate in the iron. This in the best machines is only partially attained. The effect of such currents on the characteristic surface is the same as increasing the current in the armature. If the lead is negative the induction is increased both by the current in the sections of the armature and in the iron; but such a negative lead must give rise to destructive sparking, as the sections will be commuted in a strong field.

Effects of Lightning on Railway Signals.

The effect of lightning on electrical apparatus of all sorts is a subject on which accurate data seem rather scarce, and its effect on railroad signals especially is a point on which more light is needed. A cardinal principle in signals which are in any degree automatic is that they shall show danger in the event of any derangement, and numberless ingenious devices have been invented to provide against the possibility of a signal standing at safety when it has not been intelligently put in that position; but lightning is such a lawless element and may influence electrical apparatus in so many different ways that the counteracting of the harm it may do is not an easy task. It may make a ground connection, and thus allow a circuit to appear all right when it is not, being closed at one end and open (without battery) at the other. It may melt fixtures so as to permanently hold a signal in the position it is in at the moment; and again it may charge a wire with a current that will actuate the electro-magnets and work the signals when the signal man has taken no action whatever. While the chances of a signal being held any length of time in the safety position from the effects of lightning alone are very small, and while it is probable that nearly or quite all danger in this respect can be guarded against by cautionary instructions to the attendants, it is nevertheless well to make note of all pecularities noticed, that experience may be compared. In a recent thunder storm at Palmer, Mass., the electric locks on the interlocking machine at the crossing of the Boston & Albany and New London Northern were alternately locked and unlocked several times by atmospheric electricity in the rails at and near the crossing. The storm also showed one of the disadvantages of underground wires. A lightning shock generally runs along a wire until it encounters more than ordinary resistance and then melts the conductor. An underground wire is more likely to have unequally corroded sections than an aerial one, and so furnishes first-class opportunities for the lightning to fuse and part it, where, in the case of a wire hung in the air, the resistance and damage would more likely occur in the office connections or apparatus. As is well known, the electric locks of the Union Signal Company's interlocking machines are so arranged that the circuit, through the rails, when closed, holds the armature away from its slot, and thus leaves the lever unlocked, so that any breaking of a connection by lightning or otherwise will lock the lever, which is in the direction of safety. But anything which should connect the two parts of the circuit so as to leave it normal with the rails excluded would leave the levers permanently unlocked.—*Railroad Gazette.*

Pacific Railroads and the Telegraph.

Last week General Manager Bates, of the Baltimore & Ohio Telegraph Company, who had testified before the Congressional Committee last year about the Pacific Railroads and their relation to the telegraph business, appeared before the new commission, in response to the Commission's order, and was asked if he wished to supplement the evidence he then gave with anything further. He replied that he did not. The record of this testimony was then put in evidence.

Ex-Judge Dillon asked that the evidence of Dr. Norvin Green, Sidney Dillon and others, taken at the same time with that of Mr. Bates, be also incorporated in the record. Mr. Dillon here explained the relation of the Union Pacific Railroad and the Western Union Telegraph Company as he had already done before the Commission, showing that the Western Union had its lines on the Union Pacific under act of Congress—adding that the report of the Warner Committee showed on its face that the members were ignorant of the statutory and adjudicated rights of the Union Pacific and the telegraph companies, or they would not have said that the contract between the two companies was illegal.

General Wager Swayne, counsel for the Western Union Telegraph Company, made a few remarks at this point saying, among other things: "If the contract between the Union Pacific and Western Union was abrogated to-day there is an injunction, granted by Judge McCreery, preventing the Union Pacific Railroad from doing business on its own telegraph lines until it has settled its debt to the Western Union, amounting to some millions of dollars." He then referred to what he called the "hypothetical" testimony given by Mr. Bates, of the Baltimore & Ohio Telegraph Company, before the Congressional Committee. This led his associate counsel, Mr. Dillon, to remark.

"The trouble is that the Baltimore & Ohio people that they can manage our business better than we can ourselves."

Fuel and Food by Electricity.

Dr. Werner Siemens, one of the most distinguished men of science now living, stirred up, a few years ago, a rather lively controversy in the scientific world by a suggestion that it might be possible, after the world's supply of coal and wood had been exhausted, to warm the chilled bodies of the unfortunate men of that period by means of some application of electricity as yet undiscovered, with which he coupled, also, the idea that it was at least conceivable that similar means might be employed for nourishing the human race after all vestiges of plant life had disappeared from the earth. It is not unlikely that even scientific men are fond of a good dinner now and then, and the idea of feeding on electric currents seems to have been more than they could endure, for Dr. Siemens was attacked with considerable warmth as a visionary who amused himself with idle fancies instead of scientific reasoning. A few months ago, however, the venerable philosopher took occasion to explain his theory, which, curious as it is, is, as he says, anything but the idle fancy which it was accused of being.

"Science believes," said Dr. Siemens, in the interesting address which we find quoted in the *Schweizerische Bauzeitung*, "that all substances have connected with them a certain portion of energy, which, like the elements with which it is associated, is indestructible; modifying often its form and relations, but always traceable and constant throughout its changes. When a substance combines chemically with another, it often happens that the compound substance formed by the combination, by some quality of its constitution which we know nothing of, associates itself with a smaller relative proportion of energy than that proper to the substances of which it is composed, and in the act of combination this surplus of energy, which no longer finds a place in the new substance, is set free, and manifests itself as heat or light. The burning of coal is a familiar example of this. The carbon of a given quantity of coal, and the oxygen with which that quantity of coal will unite, possesses more energy than the carbonic acid formed by the union of the two elementary substances; and in that union the excess of energy is disengaged as heat. The same thing takes place when wood or any other substance is burned. Now it is remarkable that, although we can obtain this manifestation of surplus energy to warm our hands with, by the combination of many of the substances now existing around us, the separation of the compounds, so that we can combine their elements again when we want more heat, is a very different matter; and when all the coal and wood are gone we shall find it very hard to get them back again out of the carbonic acid into which we have resolved them. In fact, there are only two common agencies by which the bond between chemical compounds can be directly dissolved. One of these is light, the decomposing effect of which is as yet not well understood, and the other is electricity, which is now constantly used to effect chemical decomposition in the arts." It is certainly not unreasonable to suppose that we shall some time use it more effectively for this purpose than we now do, and, although the decomposition of carbonic acid, or of water, which is perfectly practicable, would yield rather unmanageable gases, it is, as Dr. Siemens says, quite within the bounds of possibility that the mechanical force derived from wind, or falling water, or waves converted into electricity by revolving magnets or otherwise, may hereafter be used for producing, by decomposition, potassium, or magnesium, or some other solid, portable, and tolerably effective fuel.

While we could reconcile ourselves, if necessary, to the idea of sitting around a potassium fire on winter evenings, there would be still a considerable step to be taken before reaching the production of food by electricity, and here Dr. Siemens only ventures to indicate rather vaguely the way which he thinks it possible that science might follow. So far as we know, the most essential element of food is nitrogen, which we consume in combination with a great variety of other substances. Now these combinations of nitrogen with other substances are effected in nature mainly by the obscure processes of vegetable life, nitrogen in its natural state having no disposition to combine with other elements, even when aided by heat. By indirect chemical action it is possible to force nitrogen into combination with oxygen, to form nitric acid, and with hydrogen, to form ammonia; but neither of these substances is edible, and after all vegetable life had disappeared from the world we should certainly starve if we had nothing better than such things to depend upon. Here, however, electricity comes to our aid in a new way. Although one form of electric current, that of low tension, forms the most powerful decomposing agent we know, a current of high tension may be made, either directly or by induction, to exert a powerful combining force. By passing the sparks of an induced current of high tension through air, the condition of the atmospheric oxygen is changed. It becomes ozone, and in that form seizes upon the nitrogen with which it was before only mixed and combines with it, forming a vapor of nitric acid, which shows itself to our senses by the "sulphuric smell" which follows the sparks of a frictional electrical machine, or a Ruhmkorff coil, or a flash of lightning. Whether nitrogen may by similar means be made to unite with carbon, hydrogen and the other elements of organic substances it is for the electrical chemistry of the future to decide; but it cannot be said that it is scientifically impossible.—*Am. Architect.*

French Telegraph Lines.

There are now twelve telegraph wires between Paris and London, besides two wires between Marseilles and London, with junctions at Paris. There are ten telegraph wires from Paris to Germany, viz., four to Berlin, two to Frankfort, one to Cologne, one to Hamburg, one to Strasbourg, and one to Mulhouse. Metz has no direct telegraphic communication with Paris. To Austria three wires have been carried from Paris, viz., two to Vienna and one to Bregenz. As regards Belgium, there are two wires from Paris to Brussels, and two from Paris to Antwerp. Denmark is united directly to Paris by a submarine cable from Frederica to Calais. Only one wire has been carried to Spain, viz., from Paris to Madrid. Two wires have been stretched from Paris to Amsterdam. Italy has six wires from Paris, viz., two to Rome, one to Florence, one to Turin, one to Genoa, and another to Milan. There are four wires between France and Switzerland, viz., two to Geneva, one to Basle, and one to Berne. As regards the internal telegraphic system of France, it may be added that six wires now unite Paris to Marseilles; Bordeaux and Lyons have each four wires; Lille, Havre, Brest, and Toulouse have three each; and Amiens, Montpelier, and Nantes have two wires each. All the other provincial préfectures are united to Paris by a single wire with the following exceptions: Tuille, Quimper, Mont-de-Marsan, Foix, Carcassonne, Privas, Gap, Digne, Mende, and Ajaccio. These omissions will shortly be made good.

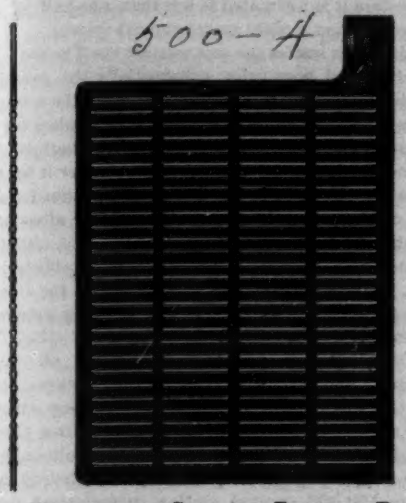
Formulæ for Self-Regulating Dynamos.

Writing in reply to a correspondent of the London *Electrician*, Prof. S. P. Thompson says: The question whether the mathematical formulæ given in my book for the conditions necessary for the self-regulation of dynamos are found to be in accord with the practice of manufacturers, is readily answered. The formulæ themselves are in general not; the practical conclusions to which they lead are. For example, the formula No. XXVII. for compounding a dynamo for constant potential is not verified in practice. More series turns are required than that formula indicates, and the reason is simply this: The assumption is frankly made at the outset that the iron in the field-magnet cores is never saturated, and that its magnetism is therefore always proportional to the number of ampère turns exciting it, whereas in actual constant potential machines the series coil is required to come into use most powerfully when the iron cores are well on toward saturation; hence, more series turns are wanted than the theory indicates. But, on the other hand, the practical rule which follows for ascertaining by experiment how many series turns are actually wanted to give self-regulation is constantly used by manufacturers of dynamos. Again, the formulæ for compounding machines, to make them self-regulat-

ing for constant currents, are not used, for the additional reason that they would involve an enormous cost for the immense number of turns of wire in the shunt winding. In the expressions for self-regulating motors the formulæ are, however, again good, because in the constant speed motor, running on contant potential mains, the maximum power exerted by the series coils is called forth, not when the field-magnets are most powerfully excited and well saturated, but when they are least excited and furthest from saturation. There will be something said on these points in my forthcoming new edition.

Reckenzaun's Secondary Battery.

In seeking to overcome the difficulties met with in the storage battery, Mr. Anthony Reckenzaun has devised an ingenious method of applying the active material to the plate. In his method the material is completely formed in advance of its application, and is held in place in such a manner that the expansion of the plate has no effect on the



THE RECKENZAUN STORAGE BATTERY PLATE.

adhesive property of the active material. Mr. Reckenzaun, in constructing the plates of his battery, prepares small cylinders of peroxide of lead, and places them at short distances from each other and in regular lines upon the lower half of a corrugated mold. The two halves being fitted together, the molten metal is poured in, forming a composite plate.

As the illustrations show, the small cylinders of active material are exposed for a large part of their surface to the direct action of the electrolyte, being held only at the top. But the inclosing metal is sufficient to permit the plate to be bent over into a complete circle without causing the small cylinders to fall out. Hence the danger from buckling or bending of the plates is entirely avoided, as the active material is firmly held in place, the expansion taking place entirely in the direction of the length of the cylinders.

Some of these cells have been in continuous operation for about 20 months without showing signs of deterioration, and by the construction adopted they are specially fitted for street car and other trying work where rough usage, careless treatment and excessive rate of discharge are inevitable.

Electric Lighting in German Provincial Towns.

A correspondent of *Industries* gives the following particulars respecting some installations in Germany: "The public supply of electricity from central stations is not limited to Berlin only, but is beginning to obtain a footing in various provincial towns throughout Germany. In Hanover there are two small stations already in activity, one for the supply of private customers and the other for the lighting of the Court Theatre. In this case alternating currents and transformers are used, the transmission being by means of an overhead iron wire 100 mils. in diameter, at a potential of 1,200 volts. The total commercial efficiency of the system is 58 per cent. A larger central station with underground cables for the supply of the inner portions of the town is in contemplation. In Magdeburg there is a small central station for lighting a block of houses, including hotels and shops, in the neighborhood of the railway station, and in addition to this a separate installation for the theatre is now being fitted up. There will be two gas engines of 35 horse-power each placed in an annex, and the building will be lighted from the dynamos direct. The works of Gruson and Schäffer and Budenberg, in Buckau, have also special electric light installations. In Brunswick, a private person has erected a central station for 1,000 lamps, all the light being in a block of houses containing business premises. In Dessau, which is the headquarters of the Continental Gas Company, there is a very interesting installation which has been at work since last year, lighting principally the Court Theatre and the Castle with about 2,000 lamps. Power is furnished by four Otto gas engines, two of them 60 horse-power, and one 30 horse-power, working together on a countershaft, from which two 600-light and one 450-light dynamos are driven. The fourth gas engine is an 8 horse-power working a 100-light dynamo, which is used for charging a battery of Khotinsky accumulators, having a total capacity of 600 lamp hours. The cost of the whole installation was about $75,000.

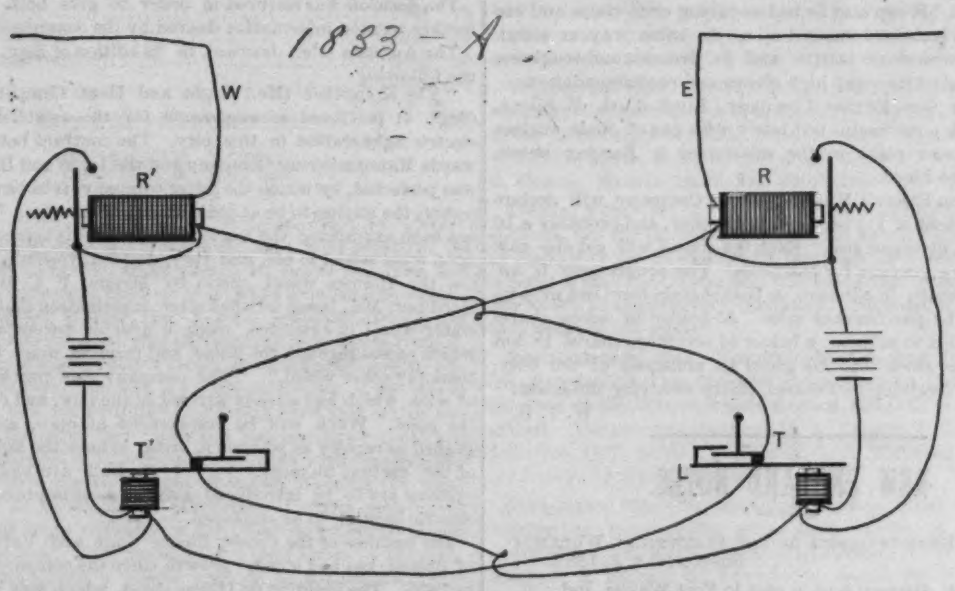
Thermal and Electrical Chemistry.

We extract the following from the B. A. Presidential address: "But recent investigation in another direction bids fair even to eclipse the results which have been obtained by the examination of thermal phenomena. And this lies in the region of electrical chemistry. Faraday's work relating to conductivity of chemical substances has been already referred to, and this has been since substantiated and extended to pure substances by Kohlrausch. It has been shown, for example, that the resistance of absolutely pure water is almost an infinite quantity. But a small quantity of an acid, such as acetic or butyric acid, greatly increases the conductivity; but more than this, it is possible by determination of the conductivity of a mixture of water with these two acids to arrive at a conclusion as to the partition of the molecules of the water between the acids. Such a partition, however, implies a change of position, and therefore we are furnished with a means of recognizing the motion of the molecules in a liquid, and of determining its amount. Thus it has been found that the hindrance to molecular motion is more effected by the chemical character of the liquid than by physical characters such as viscosity. We have seen that chemical change is always accompanied by molecular motion, and further evidence of the truth of this is gained from the extraordinary chemical inactivity of pure unmixed substances. Thus pure anhydrous hydrochloric acid does not act upon lime, whereas the addition of even a trace of moisture sets up a most active chemical change, and hundreds of other examples of a similar kind might be stated. Bearing in mind that these pure anhydrous compounds do not conduct, we are led to the conclusion that an intimate relation exists between chemical activity and conductivity. And we need not stop here; for a method is indicated indeed by which it will be possible to arrive at a measure of chemical affinity from determination of conductivity. It has indeed been already shown that the rate of change in the saponification of acetic ether is directly proportional to the conductivity of the liquid employed. Such wide-reaching inquiries into new and fertile fields, in which we seem to come into nearer touch with the molecular state of matter, and within a measurable distance of accurate mathematical expression, leads to confident hope that Lord Rayleigh's pregnant words at Montreal may ere long be realized: 'It is from the further study of electrolysis that we may expect to gain improved views as to the nature of chemical reactions, and of the forces concerned in bringing them about: and I cannot help thinking that the next great advance, of which we already have some foreshadowing, will come on this side.'"

A New Repeater Arrangement.

BY W. S. CHESLEY.

In this age of invention the tendency is to do away with all complications in mechanism; everything is being simplified and we are constantly improving upon original ideas. I have no doubt that most of your readers who



A NEW REPEATER ARRANGEMENT.

are connected with the telegraph service have at some time experienced the annoyance incident upon unsatisfactory working of repeaters at intermediate repeater stations, probably caused by the lack of attention or the inability of the attendant to properly adjust them. In reflecting upon this matter I have devised a set of repeaters, using common instruments, which reduces the complication to a minimum.

The action of the repeater, which consists of common relay and single transmitter, is as follows: East line opens, opening its transmitter *T*, which opens the west line. At the same instant the tongue of the transmitter makes contact with the lever, which closes the local circuit of the west transmitter *T'*, so that the west relay cannot open it. Both relays *R*, *R'* work at the same time, but the local points of the west relay are cut out when the east transmitter is open. When the west line breaks, the action is reversed. No extra local magnets or batteries are required. Half of the set can also be used for a single line on one side of a quadruplex.

Regulating Processions by Telephone.

In connection with a jubilee *fête* given recently to 37,000 Glasgow children, an interesting experiment was made with the telephone, showing to what use it might be put in actual warfare, and how, in the event of a city being besieged, the instrument might be utilized for directing the movements of troops within its walls, thus superseding orderlies. At the headquarters in the Green a telephone was fitted up, connected by special wire with a similar instrument in the exhibition office of 37 St. Vincent Place. In the exhibition buildings the committee had also the use of ordinary telephones; these, through the medium of the telephone exchange, enabling Major Cunningham, who conducted the experiments, and his staff to keep in touch with the different parts of the city. About one o'clock a message was received from the headquarters at the Green stating that a block had occurred, and requesting that the processions of children from the various quarters of the city might be delayed for 20 minutes. Persons stationed at various points were immediately informed by telephone of the request, with the result that the processions were stopped until the block had been removed and the inclosed space on the green was ready to receive a further installment. By means of this system of telephonic communication Major Cunningham was also kept constantly informed of the number of children in each procession as it passed the given points. In case his services might be required, a surgeon, with an ambulance wagon, was stationed in St. Vincent Place, whence he could be sent to any part of the city.

The Bain Four Pole Motor.

We give below a few details of the motor designed and manufactured by Forée Bain, of Chicago. The field and armature core of the machine are made entirely of wrought iron, the former being quadripolar, with like poles opposite each other. The novelty in this machine consists in the manner in which the armature is wound and connected, and also in the windings and connections of the field-magnets, the object being to produce a self-regulating motor.

The armature contains eight coils, divided into two groups, the coils of each group being situated quadrilaterally with respect to each other. The current circulates in these groups alternately, and only at a point where the greatest effect is produced. The other group of coils are at this time passing the neutral points of the field magnets, and should they remain active they would partially act to retard the motion of the armature by their relation to the field. In order to avoid this they are cut out of circuit at this point, and their connections are so arranged with relation to one another that in order to prevent their "discharge" at the commutator and brushes they are at that instant put in circuit by themselves in such manner that the current circulating in the two "positive" coils of the group is just neutralized, or balanced, by that in the two "negative" coils of the group.

By this arrangement the idle portion of the armature is removed from the circuit without being followed by bad results produced by the sparking. By this connection also the internal resistance of the armature is reduced to one-fourth that of a bipolar Gramme machine, thus reducing the internal loss to a minimum and increasing the efficiency accordingly.

The manner of producing self-regulation is the subject of a patent now pending and cannot be fully described. It is claimed to be neither a shunt nor compound winding.

We are informed that a motor of 5 h. p. of this form, of 40 ampères capacity and 100 volts, occupies a floor space of 18 inches square and weighs only 260 pounds.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
NEW YORK, Oct. 3, 1887.

The Hewes & Phillips Iron Works, of Newark, N. J., are very busy executing orders for their Corliss engines. These engines embody several really valuable improvements, such as extra heavy beds and large wearing surfaces, steam and exhaust parts of increased area, all valves wiping over the edges of raised seats at all points of cut-off, preventing the wearing of shoulders. The valve gear is very simple, composed of few parts, quick and certain in operation, works without noise, and is adapted to high rotative speeds. The improved vacuum dash pots are also noiseless and unusually quick in motion. They are entirely enclosed requiring no outlet for compressed air, which is used alternately on top and bottom of the sides of the piston. The governor is composed of few parts, and will regulate the engine within one revolution between all ranges of load. Particular pains are taken with these engines in all details of fitting and finish. They are durable, capable of driving heavy loads for long continuous runs, and operate without thumping or noise.

The New England manufacturers are quick to see merit in modern engineering, and in several instances have shown their appreciation of the Hewes & Phillips Iron Works Corliss engines by placing their orders with this firm, as shown by the compound condensing engines now building. Among other work now in the hops, are two tandem engines and five boilers for the Goodyear Metallic Rubber Shoe Company, of Naugatuck, Ct.; a pair for Willimantic Linen Company, of Willimantic, Ct.; a pair for he Merrick Thread Company, of Holyoke, Mass., and two boilers and a tandem engine for the new electric light plant of the Thomson-Houston Company, in this city. These engines will average about 700 h. p., and the boilers are 250 h. p. each, built to carry 150 lbs. pressure. The Hewes & Phillips Iron Works are building quite a number of simp le engines, but are paying particular attention to compound and triple expansion engines. They are also building the Manning boiler of large sizes, to carry from 125 to 175 lbs. working pressure. These engines and boilers are said to develop 1. h. p. for about 1.6 lbs. of coal.

The Electric Time Company, of 10 Broad street, have completed a large tower clock on Narragansett Pier and are putting one up in Boston, and one in the city hall at Hoboken.

I understand that the Mutual Electric Company have closed a contract for the sole control of the Johnson composition rubber for storage and acid batteries.

The United States Electric Fire Alarm Company of Evart, Mich., is, I hear, one of the latest to enter a field in which there are already some active and burly competitors.

I met in town last week, Mr. S. B. Paine, of Paine & Francis, Edison agents in Boston. He spoke very strongly in commendation of the new cut-out they have been introducing in several calities in the East. Mr. Paine also represents the New England Wiring and Construction Company.

The attention of electrical engineers has of late been drawn to the merits of the new insulating compound, Vulcabeston, made by the H. W. Johns Manufacturing Company, 87 Maiden Lane, this city. This substance is a composition of rubber and asbestos, the latter being about 60 per cent. of the whole. The compound is said to resist all temperatures, to be acid and waterproof, and to take safely the highest electromotive forces used in practical work. It thus serves to make a very durable case for batteries, especially storage; while its non-conducting qualities render it a desirable adjunct in dynamos and motors, telegraph instruments, telephones, etc. It is made in hard sheets from $\frac{1}{8}$ inch upward and can be worked into any form—stamped, drilled, bored, threaded, punched, or highly polished without injury. It can also be had as tubing or in rings, and can be worked in a lathe and finished up in the same way as metal. It is the very reverse of brittle, and its firmness and toughness are not the least of its many high claims and recommendations.

The Korting Gas Engine Company, Limited, G. E. Silcox, Manager, made a successful test lately with one of their engines on a Brush-Swan plant in the salesrooms in Barclay street, opposite College Place.

The American Electric Manufacturing Company will declare a regular dividend of 1½ per cent. in October, and probably a 10 per cent. stock dividend also. Each ten shares will get one new share, with no allowance for fractions. The programme is announced unofficially in advance, so that shareholders can even up their holdings by purchases or sales. A holder of seven shares would be entitled to nothing, a holder of seventeen shares to but one share. The stock will be given to multiples of ten only, twenty shares receiving two shares, thirty receiving three, etc.

W. T. H.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
BOSTON, Oct. 3, 1887.

Mr. M. M. M. Slattery is on a visit to Fort Wayne, Ind.

Mr. H. F. Swift, formerly of the firm of Swift & Smith, Attleboro, Mass., is now in charge of the manufacturing department of the Electric Gas Lighting Company, Boston.

The Simplex Electrical Company, of Boston, reports having made several large shipments of its wire product during the past month. One order was for sixteen miles of wire to Italy.

The Portland (Me.) Electric Light and Power Company received from the Wainwright Manufacturing Company, of Boston, recently a corrugated tube feed water heater of 100 h. p. capacity.

Mr. George J. Morse, agent of the American Electric Manufacturing Company, stated in my presence a few days ago that "at a meeting of the special committee on electric lighting for the town of Hyde Park, held on the evening of Sept. 30, it was voted to accept the proposition of the American Electric Manufacturing Company for lighting the streets of that town for a period of three or five years." It is reported that the bid submitted by Mr. Morse was to furnish from 60 to 90 arc lights (of 1,200 c. p.) at the rate of $70 per annum for each light.

The New England Wiring and Construction Company, of Boston, is daily in receipt of letters of inquiry from all sections of the country concerning its multiple switch system which it had on exhibition in THE ELECTRICAL WORLD headquarters at the National Electric Light Convention in Boston. The apparatus connected with this system is simple and reasonable in price, yet thoroughly reliable. It is undoubtedly a valuable adjunct to isolated plants of incandescent electric lighting.

Messrs. Paine & Francis, the N. E. agents of the Edison United Manufacturing Company, report the following installation of isolated incandescent (Edison) plants recently made by them: The woolen mill of Messrs. Akers & Taylor, Charlton, Mass., and the factory of the Metropolitan Rubber Company, Reading, Mass.

Among the important petitions presented before the Boston Board of Aldermen on Tuesday, Sept. 27, was one from Mr. Prentiss Cummings, president of the Cambridge, Mass., Railroad Company, requesting permission to run one or more cars between Cambridge and Boston by means of electricity. The following order was passed:

Ordered, That the Cambridge Railroad Company be authorized, until otherwise ordered by this board, to use electricity in propelling one or more of its cars within the limits of the city of Boston, provided that such use shall be by means of storage batteries.

The Boston Sunday *Herald*, Oct. 2, contained the following account of an electric light hearing at New Bedford, Mass.:

The hearing on the petition of the New Bedford Gas Light Company to operate electric lights in the city of New Bedford, was continued yesterday morning at the rooms of the gas commissioners on Beacon street. The morning session was devoted entirely to the hearing of expert testimony submitted on behalf of the remonstrants (the Edison Illuminating Company of New Bedford), in rebuttal of the statements made at the previous hearing before the commissioners by the Westinghouse experts, attacking the economy and desirability of the Edison system. The testimony submitted at this hearing was to prove that the Edison system was fully capable of doing, and the company fully prepared to do, whatever incandescent electric lighting was required in New Bedford, and that the Westinghouse system, which the gas company will probably put in if their petition is granted, is not capable of doing what is claimed for it. The president and the treasurer of the Edison Illuminating Company both testified that, of a capital of $100,000, every dollar is expended honestly, and there is not a dollar's worth of water in their stock. They further submitted that when they went into the business of furnishing incandescent lights in the city of New Bedford, they expected the competition of electric light companies, and were prepared to meet it, but, in case the petition under consideration was granted, the gas company would avail themselves of the power thus given them, and crush the local Edison company by doing the electric lighting business at a loss for a few years if necessary, trusting to the profits on their gas plant, and the reserve fund they have accumulated, to support them meanwhile; that after they succeed in driving the weaker company to the wall, they would increase their rate, and the consumer of electric lights would not be as well served as at present. They state that the failure of their company would mean the injury of a great many of the New Bedford people, inasmuch as the stock of their company is almost entirely held in small quantities by the citizens. It was shown that their company had paid but a 2½ per cent. dividend the first year, and they had trusted to the further development of their business to increase the profits.

Mr. Barney, counsel for the petitioners, called the attention of the commissioners to the fact that the Legislature last winter had decided that it was quite proper for gas companies to engage in the electric lightning business, and stated that they probably considered, before passing the bill, the matter of local competition between electric light companies proper and gas companies running electric lights.

The decision was reserved in order to give both parties some further written information desired by the commissioners.

The Augusta (Me.) *Journal*, in its edition of Sept. 5, contained the following:

"The Kennebec (Me.) Light and Heat Company yesterday (Sept. 4) perfected arrangements for the establishment of an electric light station in this city. The contract between the Edwards Manufacturing Company and the Light and Heat Company was perfected, by which the latter company is to have 400 horsepower, the station to be at the east end of the dam. The company has been examining the various water wheels before determining upon what wheel to use, and they decided yesterday (Sept. 4) to use the Holmes wheel, made by Messrs. P. C. Holmes & Co., Gardiner, Me., being satisfied after examination that it is the best water-wheel in existence, using a greater percentage of water which passes through the flume, and running much more steadily than any other wheel." "The company has purchased 20 miles of wire, which has already arrived in the city, and contracted for the poles. Work will be commenced at once, and it will be pushed as rapidly as possible in order to have the light introduced at the earliest moment. * * * * Both arc and incandescent systems are to be introduced, and the most improved methods of electric lighting to be employed."

The business of the Crosby Steam Gage and Valve Company, of Boston, has had steady growth since the company was formed in 1875. The building on Oliver street, which they have occupied since 1881, is completely outgrown, and they have been obliged to seek more spacious quarters. With this end in view they have purchased land within the city limits and erected a large and substantial factory, especially adapted to their needs. The main building is 125 feet long and 45 feet wide, three stories high above a light and airy basement. An L 70 feet long and 46 feet wide contains foundry, blacksmith shop and boiler room. The whole is built of brick in the most thorough and substantial manner and with special regard to the health and comfort of the employés. It is supplied with all the best known and approved appliances for the prevention and extinction of fire. The rooms are of ample height and have abundant window space for the admission of light and air on all sides. This company are adding to their present large equipment a good many new machines and tools of special design adapted to the particular requirements of their various products, many of which—like the steam gage indicator, the higher grades of pressure gages and other recording instruments—require the utmost nicety and precision in their construction. With such largely increased facilities for manufacturing their specialties, the company expect to be able to meet promptly all demands which the trade may make upon them for their well-known products in the steam goods line. The new building will be ready for occupancy about the middle of October. The salesrooms and offices of the company will remain at No. 95 Oliver street, as heretofore.

The following local item, with regard to the important combination already announced in your columns, will interest many readers:

"The Westinghouse Electric Company, of Pittsburgh, Pa., and the Thomson-Houston Electric Company, of Boston, have made important arrangements by which these companies will hereafter be worked in harmony. The Westinghouse Company control the Gaulard-Gibbs system for this country. This system, it is stated, distributes high-tension currents over small wires, and these currents are connected by a simple device at each point of consumption, without loss of power, into low tension currents, thus making it possible to supply buildings with light at long distances from the central station, at an inconsiderable additional expense. As a consequence small and scattered communities need no longer be denied the luxury of electric lights, for 400 or 500 lamps even can now be set up and operated at a profit in country towns. The cost to the Westinghouse Company of installing a central station electric lighting plant under the Gaulard-Gibbs system it is estimated is less than one-half of that involved in constructing a plant under the old system.

"This combination settles the suit against the Thomson-Houston Company, which had been using substantially the principles involved in the Gaulard-Gibbs invention. By the terms of this settlement the Thomson Houston Company recognizes the validity of the Gaulard-Gibbs patent, owned by the Westinghouse Electric Company, and has taken a perpetual license under it for the New England States. Hereafter the Thomson-Houston Company is to enjoy the right to manufacture and supply the alternating currents apparatus in the New England States, and also for some 200 local companies which it has already established outside those limits. The Westinghouse Company, on the other hand, acquired the right to supply the electric lighting apparatus and introduce and sell the arc light plants of the Thomson-Houston Company on favorable terms all over the United States, and at the same time secures from its competitor the recognition of all its alternating current patents, as well as the payment of substantial royalties thereunder. The Westinghouse alternating current system, although on sale only since the beginning of the present year, already has under contract some 150,000 central station incandescent lights, and under the influence of this combination it may safely be predicted that the growth of the system will be even more rapid in the future. The factories of the two companies, one at Pittsburgh, the other at Lynn, are models of their kind, and are collectively of enormous capacity. They will be able to turn out all the apparatus required for 5,000 or 6,000 lights per day. No such important combination of electric lighting interests has heretofore been made, either in America or Europe; and thus these two companies are placed in an unequaled position with reference to the electric lighting business of the country." W. I. B.

PHILADELPHIA NOTES.

PHILADELPHIA, Pa., Oct. 3, 1887.

The telegraph operators in the various local offices are excited over the engagement of a number of operators in New York by the Mitkiewicz-Barker Chinese telegraph and telephone syndicate. Mr. E. Barberie, an old operator, who recently returned from China with Mitkiewicz and the Chinese Legation, and who is hiring the men, is expected in Philadelphia in a few days, and many operators are anxiously awaiting his arrival.

The syndicate, it is said, is offering $200 per month and free passage to China for good operators, and, as outside of the desire for a change the price offered is almost three times as great as first-class wages here, there are not a few operators who have expressed a desire to engage with the syndicate.

The board of managers of the recently organized Philadelphia Electrical Society state that they have secured permanent quarters in the Caffrey Building, Nos. 1712 and 1714 Chestnut street. The entire floor will be handsomely divided into eight apartments, including lecture room, reception room, reading room, billiard room, card room, coat and toilet rooms, and board rooms. The rooms are now being fitted up, and will be completed in a few days, and in order that they may be occupied as soon as possible, the regular meeting which was to have been held on the 1st has been postponed to the 8th. The society is in a flourishing condition, and it is expected that there will be a large attendance at the meeting, and that a number of new members will be enrolled. In addition to the regular business of the society, papers upon electrical subjects will be read by Messrs. Law, Griffin, Cutter and Knapp, and recitations by Mr. H. T. Paulhamus. There will also be a general discussion on the subject of batteries. Mr. M. D. Law is the president and Mr. D. R. Gibbs, secretary.

The Hunter Electric Company, through its president, William Wharton Jr., and Secretary Richard Ashurst, last Saturday filed a petition in Court of Common Pleas No. 4, asking that its name be changed to the Electric Car Company.

Apropos of the announcement in the press dispatches of a day or two ago of the consolidation, effected at Pittsburgh, of the Westinghouse and Thomson-Houston interests, the Philadelphia *Record*, one of the best informed authorities on the subject in the city, says, in its last Sunday's issue: The consolidation of the Westinghouse Electric Light Company, of Pittsburgh, which has a system of incandescent lights in operation in this State, some of which are in Philadelphia, with the Thomson-Houston Company of Boston, is looked up by electric light people as very significant. The combination between these corporations is not likely to affect the operations of electric light companies in this city, as all of the concerns here except the Keystone are combined in an Electrical Trust, formed after the style of the Gas Trusts in Chicago and Boston, and are operated harmoniously.

Electricians, however, say that the Westinghouse and the Thomson-Houston consolidation is of the utmost importance, because it is the beginning of a combination that is to extend all over the country in opposition to Mr. Edison, who has recently been granted a patent for the multiple arc system of distribution, which, if sustained by the courts, will give Mr. Edison the absolute control of the incandescent system and will compel the Westinghouse people and all of the other incandescent companies

which have been and are now supplying their special incandescent lamps from a common centre of power to either abandon their business or pay tribute to Edison.

The special patent which has been granted to Mr. Edison is for a distribution of electrical power to a system of incandescent lamps from a common station, as is now being done by all of the incandescent companies. Under the patents granted by the Patent Office, Mr. Edison can bring suit against all of the other incandescent systems for an infringement upon his patent. The strong probability that such suits may be brought is an inducement for the other companies to pool their issues. The Thomson-Houston Electric company has an arc light plant second in extent and value to only one other company in the world, and its combination with the Westinghouse Company is regarded as of the greatest importance.

In this city all of the electric lighting companies have entered into a combination, but if the claim of the Edison people to an exclusive patent in the distribution of power to incandescent lamps shall be sustained, it is by no means unlikely that the Philadelphia combination may be broken up.

The effect of the granting of this patent has been to unsettle all of the values of other incandescent distributing companies; but as Edison will be compelled to bring suit in the courts to establish the truth of the charge of infringement upon his patents by other companies, there is a vigorous legal fight in prospect.

In view of this fact compromises have been suggested, and it is likely that efforts will be made to harmonize the conflicting interests. The only company in this city which is interested especially in this state of affairs is the Keystone Company, which is not in the Trust that controls all of the electric lighting companies in Philadelphia.

The *Record* also says: The announcement of the combination of the Westinghouse and the Thomson-Houston electric light companies has undoubtedly caused something of a flurry in electric light circles. It is believed that other combinations will follow, and that the most important developments are yet to come. The Electrical Trust, through which the majority of the stock of the electric lighting companies except one which have franchises in Philadelphia is controlled, does not itself operate the corporations, and none of them have lost their separate existence or corporate individuality. The trustees hold, under certain conditions, a majority of the stock of each company (except that of the Keystone), which they have the power to use under the provisions of the Trust. In fact, the Trust is a pool under another name, with such legal protection to those who are in the deal as the trusteeship can give them. The Trust does not protect any of the combinations which are not protected already by the patent recently granted to Mr. Edison for the multiple arc system of distribution. It is a combination simply of the local companies; and if Mr. Edison's parent company should bring a suit against the Maxim Company, for instance, which is represented in the Trust, and if the courts should sustain the patent and decide that the system of distribution used by the Maxim or United States Electric Lighting Company is an infringement of the Edison patent, this corporation would be compelled to do one of three things—compromise with Edison, find a new system of distribution, or go out of business. A thoroughly well-informed electrician of this city says of the combination between the Westinghouse and the Thomson-Houston Companies: "In addition to the better position in which it places the Westinghouse Company in any fight over the use of the multiple arc system of distribution, the two companies can work much better in combination than as separate organizations for this reason—they can supply power from a common centre to the arc lights and to incandescent lamps, thus cheapening the cost. It is possible, of course, in Philadelphia under the Electrical Trust that some arrangement can be made which will enable the companies, incandescent and arc, to accomplish the same thing, by a harmonious working together of all the interests in the Trust." Capitalists interested in the electric lighting business are anxious to know how and when Mr. Edison will attempt to enforce the patent granted to him, and the present situation is likely to stimulate electricians to invent a new system of distribution which can be adopted in case Edison's suits shall be successful. In any event it looks as though there is to be a good deal of litigation before the matter shall have been disposed of.

There are now pending in the United States Courts for this circuit eight different suits, covering all the various points of incandescent lighting, brought by President Johnson, of the Edison Company, against the Keystone Company, of this city, which uses the Westinghouse system, and which is doing a large and rapidly-increasing business in the matter of central station work. The outcome of the fight is a matter of much speculation, and is awaited with a deep interest.

The recent reduction in salaries made by the Baltimore & Ohio Telegraph Company is still the all-absorbing topic of discussion among telegraphers, and some of the best class of men who lost $15 from $75 and $80 salaries have already secured other positions, while others are making strenuous efforts to find them. It is said that the Western Union has reduced its force to the extent of fifteen men, and this, in connection with the sweeping cut, makes the outlook for the "knights of the key" anything but a bright one. E.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
CHICAGO, Oct. 1, 1887.

The Electrical Contruction Company of this city are in a better position than ever for attending to contract work. They make a specialty of handling Western business for Eastern houses.

My New Orleans correspondent sends the following:

The New Orleans Gas Light Company's application for an injunction against Maurice J. Hart and the electric wire towers, filed in the Civil Court on Sept. 9, was presented to Judge F. A. Monroe, who granted the injunction only in so far as to prohibit interference with the mains of the gas company, having disregarded in his order that portion of the prayer referring to the lamp-posts. The attorneys of the company have made an application to Judge Albert Voorhies asking for an injunction to prevent any interference with its lamp-posts, and the writ was granted on a bond of $1,000.

This necessarily stops the work which had been commenced by the Tower Company. The lamp-posts of the gas company have not been in use since Dec. 31, 1885, and in 1886 all the frames and burners were removed, the company evidently thinking that the city might retrograde and some time in the future give them again the contract for street lighting.

The Tower Company will prosecute its rights promptly and diligently. Doubtless the courts, too, will expedite a final determination of the issues raised.

The severe storms of the past few days have prostrated many of the telegraph wires between New Orleans and the great news centres.

In this city considerable damage to the fire-alarm and telegraph system, has been caused by the electric wires of the Louisiana and Brush companies being blown down and falling across them at several places. A number of instruments in the offices of the Fire Alarm and Telegraph have been burnt out and otherwise injured.

Considerable "kicking" on the part of subscribers, and comment by newspapers, has been caused by the recent action of the Cumberland Telephone and Telegraph Company, operating Nashville and Memphis, Tenn., in advancing the rates from $60 to $72 per year, payable quarterly in advance at the office of the company. This means an increase of revenue for the company of about $10,000 per year in Memphis and about $12,000 in Nashville. The company explain in their printed notice that the advance is made necessary in view of the contemplated rebuilding of the exchange in Memphis. The lease on the present building expires Jan. 1, 1888, and they are looking for other quarters in which to build a new multiple board with an equipment of 1,200 lines. In some quarters the move is hardly regarded as a prudent one, in view of recent anti-telephone feeling and legislation.

The following clipped item will no doubt interest many of your readers: Dr. J. H. Rae has applied electricity to the treatment of ores at the Douglass Mill, Dayton, Nev. The method was at first tried on tailings with a view of recovering the mercury which had been lost. But it has been found even more efficient in working ores by preventing loss of mercury and amalgam. A dynamo is run in the ordinary way by the mill engine, and the wires are led to the wooden pan in which the ore is worked. One electrical circuit is applied through the ring anodes, and the other is applied at the bottom. The solution thus completes the circuit of the electric current. The ring at the bottom is a perforated gas pipe, through which passes a sufficient current of water to clean and wash off the lighter particles. Any quicksilver or silver which may float over is caught in the channel or trough encircling the pan as it overflows. In drawing off the settlers, only clean material has to be dealt with. For successful work the volts and ampère strength has to be carefully adjusted. The dynamos in use at the Douglass Mill are capable of operating seven settlers. Two new ones are being built for this mill to give the full capacity of sixteen settlers. The mill works 135 tons of ore per day. It is stated that the decrease in the cost of chemicals for a silver mill is twice the cost of treatment and power when this new process is used. In the Douglass Mill it has cut down the cost of chemicals one-half and does better work. The main feature is the reduction in the loss of mercury. After a couple of months' trial it is said to have effected last month a saving of some $5,000 over the ordinary methods.

Col. S. G. Lynch, broker, 146 La Salle street, Chicago, furnishes me with the following quotations upon telephone stock:

Bell of Mo.	$155@$157
Central Union	44@ 45
Chicago	385@ 400
Colorado	18@ 20
Cumberland	80@ 85
Great Southern	28@ 30
Iowa Union	25@ 27
Michigan	72@ 78
Missouri and Kansas	68@ 69
Rocky Mountain Bell	40@ 45
Wisconsin	105@ 107

C. H. M.

SOUTHERN NOTES.

WASHINGTON, Ga., Sept. 24, 1887.

Mr. F. H. Colley, attorney at law here, says, with regard to the wonderful magnetic well, about which so much has been said lately: "I am somewhat familiar with what is called the electric well in Talliaferro County, Ga. I have tested it myself, and though I cannot speak positively as to feeling any effects from it, I know of a great many reliable people who assure me that they do feel it very sensibly. The well is a large excavation in the side of a considerable hill, and runs into a tolerably hard rock which was broken out by the pick. It was worked originally for alum, but the negroes engaged in it, who were affected with rheumatism, finding themselves cured, brought about the discovery of what is claimed to be its electrical properties. Persons desirous of testing the well from curiosity or for curative properties go in and seat themselves. They usually place their hands on the rock, and claim to feel at first a gentle tingling in the fingers. This gradually spreads over the body, and in some instances produces a most apparent jerking and twitching of all the limbs. Patients trying it for rheumatism, invariably, so far as I can learn, complain of more or less soreness for several days after going into the well. I have myself seen a number of instances of remarkable cures effected at the place. Fully half of those visiting the well for cure claim to benefited, and I think the proportion is even far greater."

DALLAS, Tex., Sept. 28, 1887.

The Dallas Electric Railway and Light Company is a new company organized with a capital of $10,000; paid up and authorized stock of $20,000. It is building an electrical street railroad inside the fair and exposition grounds three-quarters of a mile in length, and will use the Daft system of your city. It will also build an electric light plant to light up the grounds and all exhibits. It will also be prepared to contract for and build any electric light plants, both incandescent and arc, insolated or central station, or any electric railways. Mr. D. M. Clower, who is prominently interested, has just returned from New York, where he has been busily engaged in making arrangements.

THE TELEGRAPH.

The Steamer "Mackay-Bennett."—The French steamer "La Bretagne," Captain de Jousselin, which arrived from Havre on Sunday, sighted the telegraph steamer "Mackay-Bennett" lying to near a buoy in latitude 47° 30′ and longitude 49° 40′ on Thursday previous.

Los Angeles, Cal.—The Pasadena, Los Angeles & Long Beach Railroad Company, recently incorporated at Los Angeles by J. W. Green, O. J. Johnson, F. A. Atwater, W. W. Ross and G. W. Glover with a capital stock of a million dollars, will build a road 25 miles long, and will also equip it with telegraph lines.

Operators for China.—The Chinese telegraph and telephone syndicate, about which so much has lately been printed, is now hiring operators for its Chinese work. Mr. E. Barberie, the electrician, has the matter in hand, and will, it is said, secure the men he wants in New York and Philadelphia. It is stated that as much as $200 per month will be paid for first-class men, free passage given. The interest felt in the subject by operators is shown by the number of applications we have ourselves received on this subject. It is to be hoped that the operators who go to China will have a better experience than those who were engaged some time since for Siam.

THE TELEPHONE.

The Todd Telephone.—A telephone company has been incorporated at Indianapolis with a capital stock of ten million dollars to manufacture and sell the telephone of H. O. Todd, o Washington. The directors are H. L. Todd, A. Todd, F. M Triesel, T. B. Ward, C. W. Adams and E. J. Ellis.

Erratum.—Through an inadvertence an error crept into the article entitled "Telephonic Communication between Ships at Sea," by Lieut. Bradley A. Fiske, in THE ELECTRICAL WORLD of September 24th. The last sentence of the second paragraph from the end should read, "a piece of tin towed by insulated wire," instead of "wound with insulated wire."

THE ELECTRIC LIGHT.

Hazardville, Conn.—The new mill of Gordon Bros., at Hazardville, is to be lit by the Loomis system.

Hinsdale, Mass.—A Loomis plant of 325 incandescents is to be put in the woolen mill of Hinsdale Bros.

Brainerd, Minn.—The plant now being put in at Brainerd is of the Thomson-Houston system and will start with 30 arc lights.

Bessemer, Ala.—The Bessemer Electric Light and Power Company, incorporated by E. A. Burke and others, has a capital stock of $50,000.

The Gilliland Electric Company of Adrian, Mich., has been incorporated by R. Gilliland and others, with a capital stock of $50,000.

Lake View, Ill.—The incorporation has taken place of the Union Wave Light Company, of Lake View, by J. Hufmeyer and others, with a capital stock of $50,000.

Lava Insulators.—The incorporation is announced of the D. M. Stewart Manufacturing Company, of Chattanooga, Tenn. This is the well-known concern of lava insulator makers, who are opening a new factory at Chattanooga.

Oakland, Me.—Oakland is to have the electric light. A circuit of six arc lights will be run, and next spring the town will appropriate a sum to pay for the lighting of the streets. People generally are taking lights, both in stores and dwellings.

Incandescents for Silk Mills.—Mr. E. G. Bernard, the representative of the Sawyer-Man Electric Company, has sold plants to the following silk mills: Wm. Strange Company, Paterson, N. J., 600 lights; Read & Lovett, Weatherly, Pa., 200 lights; C. Meding, Mauch Chunk, Pa., 250 lights.

Ocala, Fla.—Mr. A. E. Waterman, a leading merchant tailor at Ocala, has the exclusive franchise for lighting the city of Ocala by electricity for 10 years, with privilege for 5 years longer. It is possible that Mr. Waterman will adopt the Westinghouse system which he regards very favorably. No definite action has yet been taken in the matter.

Los Angeles, Cal.—The Pomona Gas and Electric Light Company has been incorporated at Los Angeles, Cal., with a capital stock of $50,000, of which amount $26,000 is already subscribed. The incorporators are H. A. Palmer, J. E. Packard, J. F. Taylor, O. T. Griffin, C. French, C. C. Olmstead, of Pomona, and George Lynch, of Los Gatos.

Belvidere, Ill.—The Belvidere Electric Light Company has recently been incorporated with a capital stock of $8,000 fully subscribed. The directors are C. E. Fuller, F. W. Plane, S. L. Covey, J. R. Balliett, S. Lovejoy, F. Sands, W. M. Marean and M. Travers. Mr. Fuller is connected with a prominent legal firm. The plant has not yet been purchased, but will be put in this fall.

Torrington, Conn.—The Torrington Electric Light Company, at a meeting of the directors, voted to put in an additional dynamo of 650 lights, 16 candle-power each. They have taken a lease of the east branch shop for three years, with the privilege of eight years. The Roe Bros., who own the property, will have the dam at the Winchester reservoir raised two feet above the present overflow, which will insure plenty of water the year round. The electric light is giving perfect satisfaction.—*Boston Journal of Commerce.*

Fenton, Mich.—The Fenton Electric Light and Motor Company was recently incorporated with a capital stock of $10,000; but the amount will be increased to $20,000 in the spring, when the company proposes to light the streets of the city. The company has an incandescent plant of one 600 16 c. p. dynamo, and one 160 16 c. p dynamo, both made by I. W. Colburn Company, Fitchburg, Mass. The plant is regarded as first-class in its operation. There are seven stockholders in the concern,

with Dr. L. J. Knapp as President, H. B. Latouretel as Treasurer, and F. D. Rolison as Secretary.

Mayo Plants.—Clark Bros., of Belmont, Alleghany County, Pa., have lately installed Mayo electric light plants as follows: Rasselas Lumber Company, Rasselas, Pa., 10 arc lights for their saw mill; H. C. Freck, Bradford, Pa., 5 arc lights for saw mill; Austin, Pa., Buffalo Hardware Company, 300 incandescents for mill, store and offices; the Smethport Extract Company, East Smethport, Pa., 100 incandescents for factory.

Electric Light on Russian Railways.—The Russian Minister of Ways of Communication has appointed a special commission to select the best system of electric lighting for railway carriages. This is the result of a decision recently arrived at to render the adoption of the electric light compulsory upon the principal railway companies for all passenger trains. The experiments will be conducted on the Nicolaieff Railway, and are not expected to last more than a month. The Russian Railway Company, it should be noted, has already adopted the electric light for all fast trains running between Odessa and Kieff; while it has been used in the special Imperial trains for some time past.

Iron Mountain, Mich.—The Iron Mountain Electric Light Company was incorporated recently under the laws of the State of Michigan with a capital stock of $25,000. It is using at present one No. 7 Brush arc machine up to its full capacity. It has contracted for a second No. 7 machine, and is about to order a 300 16 c p. incandescent Brush machine. It is using now a 12×18 slide valve engine with perfect success. When its extra dynamos are installed it will purchase an automatic cut-off engine. It will also double its boiler capacity, and is now looking into the merits of oil for fuel. Mr. A. D. Moore is president of the company, Mr. F. J. Trudell vice-president, and H. McDermott secretary and treasurer.

APPLICATIONS OF POWER.

Buffalo, N. Y.—The movement in favor of an electric road along Elmwood avenue, Buffalo, is growing, and the investigations made into the subject of electric roads in other parts of the country go to confirm the intentions of the projectors.

Woonsocket, R. I.—A successful trial was made last week with the first Bentley-Knight car on the electric railroad at Woonsocket. The car is equipped with the Thomson-Houston motor and has overhead connections. It ran at a speed of 10 miles an hour and was under perfect control.

England.—The Electrical Car Company, of London, England, which is about to introduce its system of automatic propulsion on one of the metropolitan tram lines, is also to build a large electrical locomotive for drawing trains on the Underground Railway. Under this system the vehicle contains the batteries, which are charged at night and worked in the day. The cars can carry five tons at over twenty miles an hour.

Elevated Railroads for Boston.—The Boston *Herald* of Sept. 26 publishes a long article on the Mayall cable, electric and pneumatic systems of elevated railroads, the invention of Mr. T. J. Mayall. These roads are illustrated by working models on State street, corner of Kilby, Boston. Mr. Mayall proposes in the electric system to supply the current direct to the track by a conductor located centrally upon and between the rails, in a kind of inverted trough to protect it from the rain, and insulated from all contact excepting that of the motor.

PERSONALS.

Mr. F. T. Viles has been appointed inspector of the Western Union Telegraph Company's city line and leased wire service at Boston.

Mrs. A. G. Bell, the wife of Prof. A. Graham Bell, though perfectly deaf, loses little of the table talk when she and her husband are entertaining a company at dinner. Without uttering a sound the famous inventor telegraphs with his lips nearly everything that is said, and she reads them cleverly as she would a book.—*N. Y. Tribune.*

Mr. W. H. Hill, manager of the Hill Clutch Works, whose clutch has recently attracted considerable attention in electric lighting circles, has left Cleveland for an extended Western trip, to include points as far west as San Francisco. Before returning he proposes to look after some large new electric plants that are being put in on the Pacific Slope and to close negotiations for others.

MISCELLANEOUS NOTES.

Erratum.—In the paper entitled "A Method of Comparing Galvanometer Coils" by Dr. J. J. Skinner, which appeared in our issue of Sept. 3, in the first value of x, page 131, last column, the sign between the two main parts of the fractional denominator should be + instead of —.

The Gaynor Electric Company has been organized at Louisville, Ky., with the following officers: J. H. Sutcliffe, president; J. J. Barret, vice-president; T. F. Gaynor, superintendent; and E. D. Hobbs, Jr., secretary and treasurer. The first three gentlemen are directors with C. R. Long and C. A. Warren. The company will manufacture the "Rapid" fire-alarm and police signal system and general electrical goods, and will also handle electrical supplies. Its capital stock is $200,000.

Edson Gauges.—The commissioners for the erection of public buildings in Philadelphia have just placed two of the Edson recording steam gauges in the new City Hall building, corner of Broad and Market streets. Mr. Potter Palmer, of Chicago, has placed an Edson gauge in the office of the business manager of the Palmer House there. The Sauquoit Silk Mills, of Scranton, Pa., have just completed extensive alterations in their steam plant, and have added an Edson gauge in order to keep the record of the pressure carried. The Durham, N. C., water-works are engaged in making tests, employing the Edson recording gauge for the purpose.

BUSINESS NOTICES.

Jordan & Gottfried, 208 Canal St., N. Y., carry a complete stock of iron and brass machine and wood screws, bolts cap and set screws, taps, dies, files, twist drills, brass and rubber in tubing, rod and sheet copper, brass, German silver, steel and iron wire, shafting, tools, etc.

STOCK QUOTATIONS.

The following list, compiled by Mr. W. H. Baker, Broker, 16 and 18 Broad street, gives the current quotations of electrical stocks:

Oct. 3, 1887.

TELEGRAPH.	Bid.	Asked.
Am. Dist.	.....	37
Am. Tel. & Cable	70	74
Cen. & So. Am.	100	110
*Com. Tel	.....	.....
*Gold & Stock	.....	.....
*Inter. Ocean Tel.	.....	.....
N. Y. Mutual	70	80
Pac. & Atl.	49	56
*Postal T. & C.	30	.....
South. & Atl.	72	80
W. U. Tel.	75⅛	76
W. U. Scrip.	.....	.....
W. U. Bonds	117	.....
Mut. U. Bonds	84¼	84¾
TELEPHONE.		
Am. Bell	219	220
Am. Speaking	105	115
Erie	33½	34
*Hudson River	.....	57
Mexican	.....	1
*N. Y. & N. J.	.....	92
N. Y. & Pa.	.....	.....
New England	41	42
*Southern Bell	125	130
ELECTRIC LIGHT.		
*Am. Electric	.....	50
*Brush	.....	50
*Brush Ill	.....	96
*Consolidated	.....	.....
*Daft	.....	.....
*Edison	130	150
*Edison Ill	85	.....
*Edison Isolated	.....	.....
*United States	.....	54
*U. S. Ill	80	.....
MOTOR.		
*Daft	.....	.....
*Sprague	.....	.....

* These stocks are so seldom dealt in that it is difficult to give prices at which they can be bought or sold. The figures given are as near as can be ascertained.

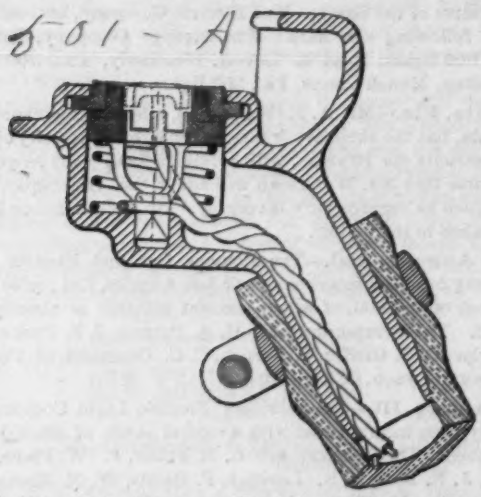
OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

PATENTS DATED SEPTEMBER 27, 1887.

(1) 370,423; (2) 370,424. Electric Lamp; J. J. Skinner, Boston, Mass. Applications filed respectively April 5 and June 21, 1886. These inventions consist of means for establishing the arc and maintaining the same in a double lamp, and consist of a separate magnet for performing each of these operations, both of which act on a common clutch mechanism of novel design. The two sets of carbons burn simultaneously, each taking half of the current. See illustration.

370,434. System of Electrical Distribution; F. A. Wessel, Brooklyn, N. Y. Application filed March, 17, 1887. This system is employed for the purpose of regulating the current supplied to any form of translating devices.

370,439. Burglar Alarm; J. B. Yeakle and A. Steuart, of Baltimore, Md. Application filed Nov. 15, 1886. One or more



370,605. COUPLING FOR PNEUMATIC BRAKE SYSTEM.

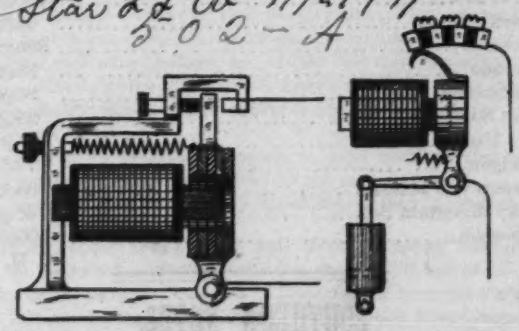
circuit-breaking devices are arranged in series with a central office alarm apparatus. The mechanism sends in signals at stated intervals to indicate that the line is in working order.

370,477. Telephone; H. V. Hayes, Cambridge, Mass. Application filed March 23, 1887. The usual central magnet is dispensed with and in its place is suspended from the inner centre of the diaphragm a permanent magnet, and there is arranged in close proximity thereto a large body of soft iron in the centre of an electro-magnetic helix, forming part of an electric circuit.

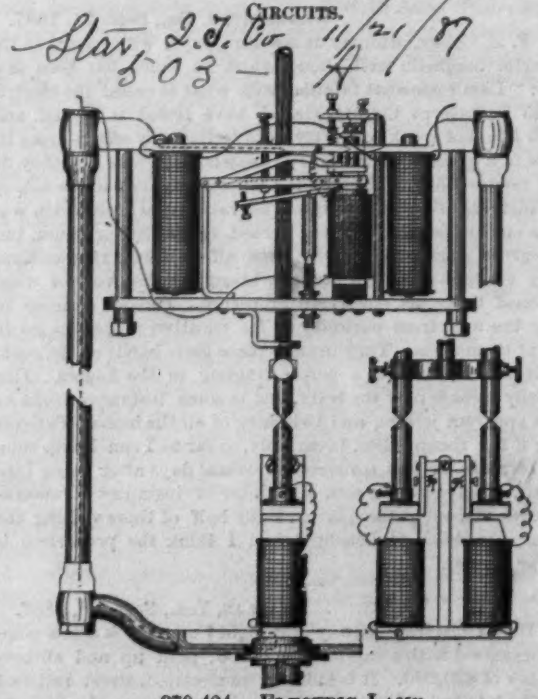
370,528. Electric Cable; F. Borel, of Cortaillod, Switzerland, Assignor to the Société d'Exploitation Des Cables Électriques Système Berthoud, Borel & Cie. Application filed Jan. 3, 1887. Layers of conductors are alternated with layers of insulation in such a manner as to form a compact and serviceable cable.

370,570. Electric Arc Lamp; E. Thomson and E. W. Rice, Jr., Lynn, Mass. Application filed April 9, 1885. The carbon-supporting lever is provided with a retractor which raises the lever so as to lift the carbon when the lamp is out of action. Devices are arranged to hold down the lever against the retractor, so as to permit the carbon to be released and come in contact with the opposite carbon and a shunting switch acting in unison with the latter.

370,573. Regulating Device for Alternate Current Circuits; E. Thomson, Lynn, Mass. Application filed April



370,573. REGULATING DEVICE FOR ALTERNATE CURRENT CIRCUITS.

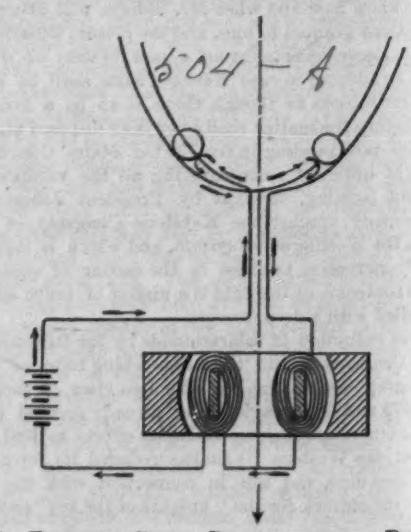


370,424. ELECTRIC LAMP.

6, 1887. This consists of a coil on an alternating-current circuit, a closed circuit in inductive relation thereto and a contact point or its equivalent, controlled by the repulsive action set up through the flow of alternating current in the coil. (See illustration.)

(1) 370,575. Electric Speed Regulator for Motors; (2) 370,576. Repeater for Harmonic Telegraphs; (3) **370,577. Phono-Multiple Telegraphy**; F. Van Rysselberghe, Brussels, Belgium. Applications filed, respectively, Sept. 8, 1886, May 2 and 4, 1887. (1) The motive power or the resistance to the motive power is varied in accordance with the position of an object moving in a parabolic curve. See illustration. (2) Receiving instruments are located in a branch circuit which connects both of two main lines to earth, said main lines being joined at a repeating station. (3) The method consists in superposing upon the line a series of isochronic simplex electric waves, and translating such waves into audible signals.

370,605. Coupling for Electro-Pneumatic Brake Systems; J. F. Carpenter, Berlin, Germany. Application filed April 8, 1887. Like halves of the coupling are united end for end. Each half carries packing material which has im-



370,575. ELECTRIC SPEED REGULATOR FOR REVOLVING MOTORS.

bedded in it the contacts for the electric conductors carried by the tubes. See illustration.

370,683. Apparatus for Use in Copying Telegraph Messages and the Like; A. C. Carey, Boston, Mass. Application filed March 3, 1887. A table arranged with a suitable frame and rolls of paper, whereby telegraphic messages may be conveniently press copied.

370,691. Printing Telegraph; S. D. Field, of New York, N. Y., Assignor to the Commercial Telegram Company of same place. Application filed December 13, 1882. Two type wheels are carried by independent shafts. The tendency is to revolve constantly in the same direction. Currents of different polarity are used to release the wheels and allow them to rotate, and for arresting one of them and holding it at a blank space while the other is printing.

Copies of the specifications and drawings complete of any of the patents mentioned in this record—or of any other patents issued since 1866—can be had from this office for 25 cents. Give the date and number of patent desired, and address Johnston's Patent Agency, Potter Building, New York.